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THE OBSERVATORY,

A

MONTHLY REVIEW OF ASTRONOMY.

EDITED BY

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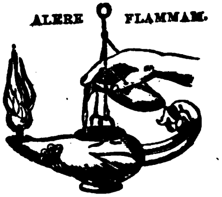
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ANNUAL COMPANION

TO

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 235. 1896. Vol. XIX.

INTRODUCTION.

The present 'Companion' closely resembles that of last year.

As in former years, we have to thank Mr. Denning for revising the "Meteor Notes," and Mr. Maw for kindly supplying a number of observations of Double Stars. We are indebted to Mr. Crommelin for the list of stars to be occulted on Feb. 28.

M. Loewy has again favoured us with advance-proofs from which we have obtained the Variable Star Ephemerides. The occultations and phenomena of Jupiter's Satellites are from the 'Nautical Almanac'; the diagrams and Ephemerides of the Satellites of the other planets from the 'American Ephemeris.' The Ephemeris of Jupiter's 5th satellite is taken from R. A. S. Mon. Not. vol. lv. p. 534, and was computed by Mr. Marth from observations made by Prof. Barnard in 1893.

The "Fraction of the Year" is the fraction which has elapsed at mean noon of the particular day from mean noon on January 1. The Moon's declination is given for mean midnight. The "Longitude of the Moon's Terminator" is given for mean midnight; the letters M. and E. signifying morning and evening—that is, that the Sun is rising or setting on that particular longitude of the Moon's surface; the sign + indicates longitudes reckoned from the central meridian in a westward direction. The angles of disappearance and reappearance for occultations are reckoned from the *true* north in the direction N. E. S. W., as for double stars.

Greenwich Mean Time is used in all cases, and the astronomical day is reckoned from noon to noon as in previous years.

Date.	Day of Year.	Fr. of Year.	Sun		☉'s Dec. Noon.	M.T. at Apparent Noon.	Sid. T. at Mean Noon.	Moon's Phases.
			Sets.	Rises.				
			h m	h m	° ′	h m s	h m s	d h m
Jan. 5	5	·011	4 3	20 7	22 39 S	0 5 30	18 58 22	☾ 7 3 25
12	12	·030	4 12	20 4	21 41	8 26	19 25 58	● 14 10 19
19	19	·049	4 23	19 57	20 23	10 53	19 53 34	☽ 22 14 42
26	26	·068	4 35	19 49	18 46	12 44	20 21 9	○ 29 20 55
Feb. 2	33	·088	4 48	19 38	16 52	13 54	20 48 45	☾ 5 12 38
9	40	·107	5 1	19 26	14 44	14 25	21 16 21	● 13 4 13
16	47	·126	5 13	19 13	12 24	14 18	21 43 57	☽ 21 9 15
23	54	·145	5 26	18 59	9 54	13 36	22 11 33	○ 28 7 51
Mar. 1	61	·164	5 39	18 44	7 16	12 23	22 39 9	☾ 5 23 29
8	68	·183	5 51	18 29	4 34	10 46	23 6 45	● 13 22 48
15	75	·203	6 3	18 13	1 49 S	8 52	23 34 21	☽ 21 23 57
22	82	·222	6 15	17 57	0 57 N	6 48	0 1 57	○ 28 17 22
29	89	·241	6 26	17 41	3 41	4 39	0 29 32	
April 5	96	·260	6 38	17 25	6 23	2 33	0 57 8	☾ 4 12 24
12	103	·279	6 50	17 9	8 58	0 37	1 24 44	● 12 16 23
19	110	·298	7 2	16 55	11 27	11 58 57	1 52 20	☽ 20 10 47
26	117	·318	7 13	16 40	13 46	57 37	2 19 56	○ 27 1 47
May 3	124	·337	7 24	16 27	15 54	56 41	2 47 32	☾ 4 3 25
10	131	·356	7 35	16 15	17 50	56 13	3 15 8	● 12 7 47
17	138	·375	7 46	16 5	19 30	56 13	3 42 44	☽ 19 18 21
24	145	·394	7 55	15 57	20 55	56 40	4 10 20	○ 26 9 57
31	152	·413	8 4	15 50	22 2	57 31	4 37 55	
June 7	159	·433	8 11	15 46	22 50	58 42	5 5 31	☾ 2 20 3
14	166	·452	8 16	15 44	23 19	0 0 7	5 33 7	● 10 20 43
21	173	·471	8 18	15 45	23 27	1 38	6 0 43	☽ 17 23 41
28	180	·490	8 19	15 48	23 15	3 6	6 28 19	○ 24 18 55
July 5	187	·509	8 16	15 53	22 44	4 24	6 55 55	☾ 2 13 23
12	194	·528	8 11	16 0	21 53	5 26	7 23 31	● 10 7 35
19	201	·548	8 4	16 9	20 43	6 5	7 51 7	☽ 17 4 4
26	208	·567	7 55	16 19	19 17	6 17	8 18 43	○ 24 5 45
Aug. 2	215	·586	7 44	16 29	17 35	5 59	8 46 19	☾ 1 6 34
9	222	·605	7 32	16 40	15 39	5 13	9 13 54	● 8 17 2
16	229	·624	7 19	16 51	13 31	3 59	9 41 30	☽ 15 9 3
23	236	·643	7 4	17 2	11 12	2 19	10 9 6	○ 22 19 4
30	243	·663	6 49	17 13	8 44	0 19	10 36 42	☾ 30 22 55
Sept. 6	250	·682	6 33	17 24	6 10	11 58 3	11 4 18	● 7 1 43
13	257	·701	6 17	17 35	3 30	55 38	11 31 54	☽ 13 16 10
20	264	·720	6 1	17 47	0 48 N	53 10	11 59 30	○ 21 10 50
27	271	·739	5 45	17 58	1 56 S	50 45	12 27 6	☾ 29 13 59
Oct. 4	278	·758	5 30	18 9	4 39	48 32	12 54 41	● 6 10 18
11	285	·778	5 15	18 21	7 19	46 37	13 22 17	☽ 13 2 47
18	292	·797	5 0	18 33	9 54	45 6	13 49 53	○ 21 4 17
25	299	·816	4 45	18 45	12 23	44 5	14 17 29	☾ 29 3 21
Nov. 1	306	·835	4 31	18 58	14 41	43 40	14 45 5	● 4 19 27
8	313	·854	4 19	19 11	16 49	43 55	15 12 41	☽ 11 17 41
15	320	·873	4 8	19 23	18 42	44 51	15 40 17	○ 19 22 25
22	327	·893	4 0	19 35	20 19	46 27	16 7 53	☾ 27 14 44
29	334	·912	3 53	19 45	21 38	48 41	16 35 29	
Dec. 6	341	·931	3 50	19 54	22 36	51 29	17 3 5	● 4 5 51
13	348	·950	3 49	20 2	23 13	54 42	17 30 40	☽ 11 12 29
20	355	·969	3 50	20 6	23 27	58 7	17 58 16	○ 19 16 5
27	362	·988	3 55	20 9	23 18 S	0 1 36	18 25 52	☾ 27 0 9

For Moon's phases : ● signifies New ; ☽ First Quarter ; ○ Full ; ☾ Last Quarter.

JANUARY. Day. Month.	Week.	Moon. Rises.	Souths.	Dec.	Long. of Terminator.
		h m	h m	° '	°
1	W	4 32	13 13	24 3 N	+71·7 E.
2	Th	6 2	14 10	19 38	+59·5 E.
3	F	7 31	15 4	14 2	+47·3 E.
4	S	9 2	15 54	7 41	+35·2 E.
5	**S**	10 26	16 42	0 59 N	+23·1 E.
6	M	11 51	17 30	5 42 S	+10·9 E.
7	Tu	13 17	18 19	12 2	− 1·3 E.
8	W	14 41	19 10	17 42	−13·4 E.
9	Th	16 9	20 3	22 24	−25·6 E.
10	F	17 30	21 0	25 49	−37·7 E.
11	S	18 42	21 57	27 46	−49·9 E.
12	**S**	19 38	22 55	28 7	−62·0 E.
13	M	20 18	23 49	26 54	−74·2 E.
14	Tu	sets	……	24 18	−86·3 E.
15	W	4 44	0 41	20 36	+81·5 M.
16	Th	6 2	1 28	16 3	+69·3 M.
17	F	7 16	2 11	10 57	+57·2 M.
18	S	8 27	2 52	5 32 S	+45·0 M.
19	**S**	9 36	3 32	0 3 N	+32·8 M.
20	M	10 46	4 11	5 37	+20·7 M.
21	Tu	11 55	4 50	11 0	+ 8·5 M.
22	W	13 9	5 31	16 3	− 3·6 M.
23	Th	14 23	6 15	20 34	−15·8 M.
24	F	15 40	7 4	24 18	−28·0 M.
25	S	16 55	7 56	26 56	−40·1 M.
26	**S**	18 1	8 54	28 11	−52·3 M.
27	M	18 55	9 54	27 45	−64·5 M.
28	Tu	19 33	10 55	25 32	−76·6 M.
29	W	20 1	11 55	21 37	−88·7 M.

FEBRUARY. Day. Month.	Week.	Moon. Rises.	Souths.	Dec.	Long. of Terminator.
		h m	h m	° '	°
1	S	8 4	14 35	3 4 N	+54·8 E.
2	**S**	9 32	15 25	3 54 S	+42·6 E.
3	M	11 1	16 15	10 34	+30·5 E.
4	Tu	12 28	17 6	16 34	+18·3 E.
5	W	13 56	18 0	21 34	+ 6·1 E.
6	Th	15 21	18 55	25 18	− 6·0 E.
7	F	16 34	19 52	27 34	−18·2 E.
8	S	17 35	20 49	28 16	−30·4 E.
9	**S**	18 19	21 41	27 25	−42·5 E.
10	M	18 49	22 36	25 11	−54·7 E.
11	Tu	19 12	23 24	21 46	−66·9 E.
12	W	sets	……	17 27	−79·0 E.
13	Th	5 12	0 8	12 29	+88·8 M.
14	F	6 13	0 50	7 7	+76·6 M.
15	S	7 24	1 30	1 33 S	+64·5 M.
16	**S**	8 33	2 8	4 3 N	+52·3 M.
17	M	9 42	2 47	9 30	+40·1 M.
18	Tu	10 52	3 28	14 38	+27·9 M.
19	W	12 6	4 10	19 17	+15·8 M.
20	Th	13 21	4 56	23 14	+ 3·6 M.
21	F	14 35	5 45	26 12	− 8·6 M.
22	S	15 45	6 39	27 57	−20·7 M.
23	**S**	16 43	7 37	28 12	−32·9 M.
24	M	17 26	8 36	26 46	−45·0 M.
25	Tu	17 59	9 35	23 38	−57·2 M.
26	W	18 21	10 33	18 56	−69·4 M.
27	Th	18 38	11 28	12 59	−81·5 M.
28	F	18 53	12 21	6 11 N	+86·2 E.
29	S	19 7	13 13	1 0 S	+74·0 E.

MARCH. Day. Month.	Week.	Moon. Rises.	Souths.	Dec.	Long. of Terminator.
		h m	h m	° '	°
1	**S**	8 31	14 4	8 5 S	+61·9 E.
2	M	10 4	14 57	14 36	+49·8 E.
3	Tu	11 34	15 51	20 10	+37·6 E.
4	W	13 3	16 48	24 26	+25·4 E.
5	Th	14 25	17 46	27 10	+13·3 E.
6	F	15 31	18 44	28 15	+ 1·1 E.
7	S	16 20	19 40	27 45	−78·8 E.
8	**S**	16 54	20 33	25 49	−66·6 E.
9	M	17 19	21 21	22 40	−54·4 E.
10	Tu	17 35	22 7	18 35	−42·3 E.
11	W	17 49	22 49	13 48	−30·1 E.
12	Th	17 59	23 29	8 33	−17·9 E.
13	F	18 9	……	3 2 S	− 5·8 E.
14	S	sets	0 8	2 33 N	+83·6 M.
15	**S**	7 31	0 47	8 4	+71·4 M.
16	M	8 40	1 27	13 18	+59·3 M.
17	Tu	9 54	2 8	18 5	+47·1 M.
18	W	11 7	2 52	22 12	+34·9 M.
19	Th	12 22	3 40	25 26	+22·7 M.
20	F	13 31	4 32	27 30	+10·6 M.
21	S	14 33	5 26	28 13	− 1·7 M.
22	**S**	15 21	6 23	27 23	−13·8 M.
23	M	15 58	7 21	24 58	−26·0 M.
24	Tu	16 22	8 17	21 0	−38·2 M.
25	W	16 42	9 11	15 43	−50·4 M.
26	Th	16 57	10 4	9 23	−62·5 M.
27	F	17 12	10 56	2 24 N	−74·7 M.
28	S	17 25	11 48	4 47 S	−86·9 M.
29	**S**	rises	12 41	11 43	+80·8 E.

APRIL. Day. Month.	Week.	Moon. Rises.	Souths.	Dec.	Long. of Terminator.
		h m	h m	° '	°
1	W	12 2	15 34	26 16 S	+44·2 E.
2	Th	13 18	16 34	27 58	+32·1 E.
3	F	14 16	17 33	27 56	+19·9 E.
4	S	14 55	18 28	26 20	+ 7·7 E.
5	**S**	15 24	19 18	23 27	− 4·5 E.
6	M	15 41	20 5	19 34	−16·7 E.
7	Tu	15 56	20 48	14 56	−28·8 E.
8	W	16 9	21 29	9 49	−41·0 E.
9	Th	16 18	22 8	4 24 S	−53·2 E.
10	F	16 27	22 46	1 10 N	−65·3 E.
11	S	16 39	23 26	6 41	−77·5 E.
12	**S**	sets	……	11 59	−89·8 E.
13	M	7 45	0 7	16 54	+77·9 M.
14	Tu	8 56	0 51	21 11	+65·7 M.
15	W	10 12	1 38	24 38	+53·5 M.
16	Th	11 24	2 28	26 59	+41·3 M.
17	F	12 27	3 21	28 0	+29·1 M.
18	S	13 20	4 17	27 34	+16·9 M.
19	**S**	13 57	5 13	25 36	+ 4·7 M.
20	M	14 24	6 8	22 11	− 7·5 M.
21	Tu	14 45	7 1	17 29	−19·7 M.
22	W	15 2	7 53	11 42	−31·9 M.
23	Th	15 17	8 43	5 11 N	−54·0 M.
24	F	15 29	9 33	1 45 S	−56·2 M.
25	S	15 45	10 24	8 41	−68·4 M.
26	**S**	16 2	11 18	15 9	−80·6 M.
27	M	rises	12 15	20 42	+87·1 E.
28	Tu	9 28	13 15	24 52	+74·9 E.
29	W	10 54	14 17	27 19	+62·7 E.

MAY.					
Day.		Moon.			
Month.	Week.	Rises.	Souths.	Dec.	Long. of Termi-nator.
		h m	h m	° ′	°
1	F	12 50	16 17	26 51 S	+38·3 E.
2	S	13 23	17 11	24 18	+26·2 E.
3	**S**	13 47	18 0	20 36	+14·0 E.
4	M	14 2	18 45	16 7	+ 1·8 E.
5	Tu	14 14	19 27	11 5	−10·6 E.
6	W	14 27	20 6	5 44	−22·8 E.
7	Th	14 36	20 45	0 13 S	−35·0 E.
8	F	14 47	21 25	5 18 N	−47·2 E.
9	S	14 58	22 5	10 39	−59·3 E.
10	**S**	15 12	22 48	15 39	−71·5 E.
11	M	15 28	23 34	20 7	−83·7 E.
12	Tu	sets	……	23 47	+84·0 M.
13	W	9 12	0 24	26 24	+71·8 M.
14	Th	10 20	1 17	27 44	+59·6 M.
15	F	11 15	2 13	27 37	+47·4 M.
16	S	11 58	3 9	25 58	+35·3 M.
17	**S**	12 29	4 4	22 52	+23·1 M.
18	M	12 50	4 57	18 30	+10·9 M.
19	Tu	13 8	5 48	13 6	− 1·4 M.
20	W	13 22	6 37	6 56	−13·6 M.
21	Th	13 35	7 25	0 20 N	−25·8 M.
22	F	13 48	8 14	6 23 S	−38·0 M.
23	S	14 4	9 5	12 51	−50·1 M.
24	**S**	14 23	9 59	18 38	−62·3 M.
25	M	14 49	10 57	23 17	−74·5 M.
26	Tu	15 26	11 58	26 25	−86·8 M.
27	W	rises	13 0	27 47	+80·9 E.
28	Th	10 40	14 1	27 19	+68·7 E.
29	F	11 20	14 59	25 14	+56·5 E.
30	S	11 46	15 51	21 50	+44·3 E.

JUNE.					
Day.		Moon.			
Month.	Week.	Rises.	Souths.	Dec.	Long. of Termi-nator.
		h m	h m	° ′	°
1	M	12 21	17 22	12 32 S	+19·7 E.
2	Tu	12 33	18 3	7 12	+ 7·5 E.
3	W	12 45	18 43	1 41 S	− 4·8 E.
4	Th	12 53	19 22	3 50 N	−17·0 E.
5	F	13 4	20 2	9 14	−29·2 E.
6	S	13 16	20 44	14 20	−41·4 E.
7	**S**	13 32	21 29	18 56	−53·6 E.
8	M	13 54	22 17	22 50	−65·7 E.
9	Tu	14 21	23 10	25 46	−77·9 E.
10	W	15 4	……	27 28	+89·7 M.
11	Th	sets	0 5	27 43	+77·5 M.
12	F	9 58	1 2	26 24	+65·3 M.
13	S	10 30	1 59	23 34	+53·1 M.
14	**S**	10 56	2 54	19 24	+40·9 M.
15	M	11 15	3 45	14 10	+28·6 M.
16	Tu	11 29	4 35	8 9	+16·4 M.
17	W	11 41	5 23	1 42 N	+ 4·1 M.
18	Th	11 54	6 10	4 53 S	− 8·1 M.
19	F	12 9	6 59	11 17	−20·3 M.
20	S	12 27	7 50	17 6	−32·6 M.
21	**S**	12 48	8 45	22 0	−44·8 M.
22	M	13 21	9 43	25 33	−57·0 M.
23	Tu	14 6	10 44	27 30	−69·2 M.
24	W	15 6	11 45	27 40	−81·4 M.
25	Th	rises	12 44	26 8	+86·3 E.
26	F	9 47	13 39	23 9	+74·1 E.
27	S	10 10	14 30	19 3	+61·9 E.
28	**S**	10 26	15 16	14 12	+49·7 E.
29	M	10 39	15 58	8 53	+37·5 E.
30	Tu	10 52	16 38	3 21 S	+25·2 E.

JULY.					
Day.		Moon.			
Month.	Week.	Rises.	Souths.	Dec.	Long. of Termi-nator.
		h m	h m	° ′	°
1	W	10 59	17 18	2 14 N	+13·0 E.
2	Th	11 11	17 57	7 41	+ 0·8 E.
3	F	11 24	18 38	12 53	−11·4 E.
4	S	11 36	19 22	17 38	−23·6 E.
5	**S**	11 54	20 9	21 45	−35·8 E.
6	M	12 20	20 59	25 0	−48·1 E.
7	Tu	12 55	21 54	27 7	−60·3 E.
8	W	13 46	22 51	27 50	−72·5 E.
9	Th	14 53	23 49	27 0	−84·7 E.
10	F	sets	……	24 34	+83·0 M.
11	S	9 0	0 45	20 40	+70·8 M.
12	**S**	9 19	1 40	15 34	+58·6 M.
13	M	9 35	2 31	9 35	+46·4 M.
14	Tu	9 51	3 20	3 5 N	+34·2 M.
15	W	10 2	4 8	3 34 S	+22·0 M.
16	Th	10 16	4 57	10 2	+ 9·8 M.
17	F	10 31	5 47	15 59	− 2·5 M.
18	S	10 52	6 40	21 2	−14·8 M.
19	**S**	11 20	7 35	24 53	−27·0 M.
20	M	11 58	8 34	27 13	−39·2 M.
21	Tu	12 53	9 34	27 52	−51·4 M.
22	W	14 2	10 33	26 50	−63·6 M.
23	Th	15 20	11 29	24 18	−75·9 M.
24	F	rises	12 21	20 33	−88·1 M.
25	S	8 31	13 9	15 54	+79·7 E.
26	**S**	8 45	13 53	10 41	+67·5 E.
27	M	8 57	14 34	5 9 S	+55·3 E.
28	Tu	9 8	15 14	0 29 N	+43·1 E.
29	W	9 19	15 53	6 1	+31·1 E.
30	Th	9 29	16 33	11 20	+18·7 E.

AUGUST.					
Day.		Moon.			
Month.	Week.	Rises.	Souths.	Dec.	Long. of Termi-nator.
		h m	h m	° ′	°
1	S	9 58	18 1	20 33 N	− 5·9 E.
2	**S**	10 19	18 49	24 5	−18·1 E.
3	M	10 49	19 41	26 35	−30·3 E.
4	Tu	11 32	20 37	27 49	−42·5 E.
5	W	12 32	21 34	27 34	−54·7 E.
6	Th	13 46	22 32	25 44	−67·0 E.
7	F	15 11	23 28	22 19	−79·2 E.
8	S	sets	……	17 33	+88·6 M.
9	**S**	7 42	0 21	11 42	+76·4 M.
10	M	7 56	1 13	5 9 N	+64·2 M.
11	Tu	8 10	2 3	1 42 S	+52·0 M.
12	W	8 24	2 52	8 26	+39·7 M.
13	Th	8 38	3 43	14 40	+27·5 M.
14	F	8 58	4 36	20 2	+15·3 M.
15	S	9 23	5 31	24 12	+ 3·1 M.
16	**S**	9 57	6 29	26 53	− 9·1 M.
17	M	10 48	7 28	27 55	−21·3 M.
18	Tu	11 49	8 27	27 17	−33·5 M.
19	W	13 6	9 23	25 9	−45·7 M.
20	Th	14 24	10 15	21 44	−58·0 M.
21	F	15 43	11 4	17 22	−70·2 M.
22	S	16 58	11 49	12 19	−82·4 M.
23	**S**	rises	12 31	6 53	+85·5 E.
24	M	7 16	13 11	1 16 S	+73·3 E.
25	Tu	7 26	13 50	4 20 N	+61·1 E.
26	W	7 36	14 30	9 44	+48·9 E.
27	Th	7 49	15 11	14 46	+36·7 E.
28	F	8 4	15 55	19 16	+24·4 E.
29	S	8 22	16 41	23 2	+12·1 E.
30	**S**	8 48	17 31	25 52	− 0·1 E.

SEPTEMBER.					
Day.		Moon.			
Month.	Week.	Rises.	Souths.	Dec.	Long. of Termi-nator.
		h m	h m	° ′	°
1	Tu	10 15	19 20	27 50 N	−24·5 E.
2	W	11 22	20 16	26 39	−36·7 E.
3	Th	12 40	21 12	23 54	−48·9 E.
4	F	14 7	22 7	19 43	−61·1 E.
5	S	15 36	22 59	14 17	−73·3 E.
6	**S**	17 5	23 50	7 56	−85·5 E.
7	M	sets	……	1 3 N	+82·2 M.
8	Tu	6 28	0 41	5 57 S	+70·0 M.
9	W	6 45	1 33	12 37	+57·8 M.
10	Th	7 2	2 27	18 29	+45·6 M.
11	F	7 27	3 23	23 9	+33·4 M.
12	S	7 58	4 22	26 18	+21·2 M.
13	**S**	8 43	5 22	27 46	+ 9·0 M.
14	M	9 42	6 22	27 31	− 3·2 M.
15	Tu	10 53	7 19	25 42	−15·4 M.
16	W	12 13	8 12	22 36	−27·6 M.
17	Th	13 31	9 1	18 29	−39·7 M.
18	F	14 45	9 47	13 39	−52·0 M.
19	S	15 59	10 29	8 21	−64·2 M.
20	**S**	17 9	11 10	2 48 S	−76·4 M.
21	M	rises	11 49	2 47 N	−88·6 M.
22	Tu	5 46	12 29	8 14	+79·2 E.
23	W	5 58	13 9	13 22	+67·0 E.
24	Th	6 12	13 52	18 1	+54·8 E.
25	F	6 28	14 37	21 58	+42·6 E.
26	S	6 52	15 25	25 3	+30·4 E.
27	**S**	7 23	16 16	27 3	+18·3 E.
28	M	8 7	17 10	27 46	+ 6·1 E.
29	Tu	9 5	18 4	27 5	− 6·1 E.

OCTOBER.					
Day.		Moon.			
Month.	Week.	Rises.	Souths.	Dec.	Long. of Termi-nator.
		h m	h m	° ′	°
1	Th	11 38	19 52	21 26 N	−30·5 E.
2	F	13 4	20 44	16 38	−42·7 E.
3	S	14 31	21 35	10 47	−54·9 E.
4	**S**	16 0	22 26	4 11 N	−67·1 E.
5	M	17 30	23 18	2 48 S	−79·3 E.
6	Tu	sets	……	9 42	+88·5 M.
7	W	5 6	0 11	16 4	+76·3 M.
8	Th	5 27	1 8	21 23	+64·1 M.
9	F	5 56	2 8	25 14	+51·9 M.
10	S	6 37	3 10	27 19	+39·7 M.
11	**S**	7 32	4 12	27 34	+27·5 M.
12	M	8 43	5 12	26 8	+15·3 M.
13	Tu	10 0	6 8	23 18	+ 3·2 M.
14	W	11 19	6 59	19 23	− 9·0 M.
15	Th	12 36	7 45	14 43	−21·2 M.
16	F	13 49	8 28	9 33	−33·3 M.
17	S	14 59	9 9	4 6 S	−45·5 M.
18	**S**	16 9	9 49	1 26 N	−57·7 M.
19	M	17 20	10 28	6 53	−69·9 M.
20	Tu	18 29	11 8	12 4	−82·1 M.
21	W	rises.	11 50	16 49	+85·7 E.
22	Th	4 36	12 35	20 57	+73·5 E.
23	F	4 57	13 22	24 14	+61·3 E.
24	S	5 26	14 12	26 29	+49·1 E.
25	**S**	6 6	15 5	27 30	+36·9 E.
26	M	6 59	15 58	27 11	+24·8 E.
27	Tu	8 5	16 52	25 29	+12·7 E.
28	W	9 20	17 44	22 26	+ 0·5 E.
29	Th	10 42	18 34	18 10	−11·7 E.

NOVEMBER.					
Day.		Moon.			
Month.	Week.	Rises.	Souths.	Dec.	Long. of Termi-nator.
		h m	h m	° ′	°
1	**S**	14 56	21 2	0 8 N	−48·3 E.
2	M	16 24	21 54	6 40 S	−60·4 E
3	Tu	17 57	22 49	13 13	−72·5 E.
4	W	19 34	23 47	19 2	−84·7 E.
5	Th	sets	……	23 36	+83·1 M.
6	F	4 26	0 50	26 30	+70·9 M.
7	S	5 18	1 54	27 29	+58·7 M.
8	**S**	6 24	2 58	26 36	+46·6 M.
9	M	7 42	3 57	24 7	+34·4 M.
10	Tu	9 4	4 52	20 24	+22·3 M.
11	W	10 23	5 41	15 50	+10·1 M.
12	Th	11 38	6 26	10 44	− 2·1 M.
13	F	12 50	7 8	5 20 S	−14·2 M.
14	S	13 59	7 48	0 11 N	−26·4 M.
15	**S**	15 9	8 27	5 37	−38·6 M.
16	M	16 19	9 7	10 51	−50·7 M.
17	Tu	17 29	9 48	15 41	−62·9 M.
18	W	18 41	10 32	19 57	−75·1 M.
19	Th	19 53	11 19	23 27	−87·3 M.
20	F	rises	12 9	25 57	+80·6 M.
21	S	4 5	13 1	27 14	+68·4 E.
22	**S**	4 55	13 54	27 12	+56·3 E.
23	M	5 58	14 48	25 46	+44·1 E.
24	Tu	7 11	15 40	23 1	+31·9 E.
25	W	8 30	16 30	19 3	+19·8 E.
26	Th	9 50	17 19	14 6	+ 7·6 E.
27	F	11 12	18 6	8 22	− 4·6 E.
28	S	12 33	18 54	2 7 N	−16·7 E.
29	**S**	13 59	19 42	4 23 S	−28·9 E.

DECEMBER.					
Day.		Moon.			
Month.	Week.	Rises.	Souths.	Dec.	Long. of Termi-nator.
		h m	h m	° ′	°
1	Tu	16 56	21 28	16 46 S	−53·2 E.
2	W	18 30	22 28	21 46	−65·4 E.
3	Th	19 59	23 31	25 22	−77·5 E.
4	F	sets	……	27 11	−89·7 E.
5	S	4 0	0 36	27 4	+78·2 M.
6	**S**	5 15	1 39	25 9	+66·0 M.
7	M	6 39	2 38	21 47	+53·9 M.
8	Tu	8 2	3 31	17 21	+41·7 M.
9	W	9 21	4 19	12 16	+29·5 M.
10	Th	10 37	5 3	6 50	+17·4 M.
11	F	11 45	5 45	1 16 S	+ 5·2 M.
12	S	12 57	6 24	4 15 N	− 7·0 M.
13	**S**	14 6	7 4	9 33	−19·2 M.
14	M	15 16	7 45	14 29	−31·3 M.
15	Tu	16 27	8 28	18 54	−43·5 M.
16	W	17 39	9 13	22 37	−55·7 M.
17	Th	18 50	10 2	25 23	−67·8 M.
18	F	19 54	10 54	27 0	−80·0 M.
19	S	rises	11 48	27 18	+87·9 E.
20	**S**	3 49	12 42	26 11	+75·8 E.
21	M	5 0	13 36	23 41	+63·6 E.
22	Tu	6 18	14 28	19 55	+51·5 E.
23	W	7 40	15 17	15 6	+39·3 E.
24	Th	9 1	16 4	9 31	+27·2 E.
25	F	10 21	16 51	3 24 N	+15·0 E.
26	S	11 44	17 38	2 57 S	+ 2·8 E.
27	**S**	13 6	18 27	9 15	− 9·3 E.
28	M	14 34	19 18	15 10	−21·5 E.
29	Tu	16 3	20 14	20 20	−33·7 E.

List of the principal Meteor-showers of the Year, derived from recent Observations. By W. F. Denning.

Date.	Radiant.		Meteors.	Date.	Radiant.		Meteors.
	a	*δ*			*a*	*δ*	
Jan. 2 ...	**230°**	**+53°**	Swift; long paths.	July 28 ...	**339°**	**−12**	Slow; long.
3 ...	156	+41	Swift.	30 ...	6	+35	Swift; streaks.
11 ...	220	+13	Swift; streaks.	Aug. 4 ...	30	+36	Swift; streaks.
17 ...	295	+53	Slow; bright.	10 ...	**45**	**+57**	Swift; streaks.
22 ...	208	− 8	Very swift; streaks.	14 ...	311	+62	Rather swift.
25 ...	131	+32	Swift.	15 ...	292	+53	Swift; bright.
29 ...	213	+52	Very swift.	16 ...	61	+48	Swift; streaks.
Feb. 1 ...	211	+69	Slow; short.	21 ...	73	+41	Swift; streaks.
15 ...	236	+11	Swift; streaks.	22 ...	291	+60	Slow; bright.
15 ...	261	+ 4	Swift; streaks.	23 ...	70	+50	Swift; streaks.
20 ...	181	+34	Swift; bright.	25 ...	5	+11	Slow; short.
20 ...	263	+36	Swift; streaks.	Sept. 4 ...	346	± 0	Slow.
Mar. 1 ...	47	+45	Very slow.	7 ...	62	+37	Swift; streaks.
4 ...	175	+10	Slow; bright.	15 ...	48	+44	Very swift.
18 ...	316	+76	Slow; bright.	15 ...	77	+57	Swift; streaks.
24 ...	161	+58	Swift.	21 ...	31	+19	Slow.
27 ...	229	+32	Swift; small.	22 ...	335	+58	Slowish.
28 ...	263	+62	Rather swift.	27 ...	75	+15	Swift; streaks.
Apr. 15 ...	194	+30	Slow.	Oct. 2 ...	225	+52	Slow; bright.
18 ...	231	+17	Swift; short.	4 ...	133	+79	Swift; streaks.
19 ...	218	+33	Slow; bright.	4 ...	310	+77	Slowish.
19 ..	229	− 2	Slow; long.	8 ...	77	+31	Swift; streaks.
20 ...	**270**	**+33**	Swift.	11 ...	13	+ 6	Slow; bright.
25 ...	272	+21	Swift; short.	14 ...	40	+20	Rather swift.
26 ...	255	+37	Slowish.	14 ...	135	+68	Swift; streaks.
May 1 ...	239	+46	Small; short.	18 ...	**92**	**+15**	Swift; streaks.
5 ...	254	−21	Slowish.	20 ...	106	+12	Swift; streaks.
6 ...	**338**	**− 2**	Swift; streaks.	29 ...	109	+23	Very swift.
7 ...	244	+ 7	Slow; bright.	Nov. 1 ...	43	+22	Slow; bright.
14 ...	314	+15	Swift; streaks.	2 ...	55	+ 9	Slow; bright.
29 ...	264	+64	Slowish.	7 ...	102	+73	Very swift.
30 ...	333	+27	Swift; streaks.	13 ...	**150**	**+22**	Swift; streaks.
June 7 ...	247	−25	Slow; very bright.	16 ...	154	+41	Swift; streaks.
10 ...	261	+ 5	Very slow.	20 ...	62	+23	Slow; bright.
13 ...	310	+61	Swift; streaks.	23-27	**25**	**+44**	Very slow; trains.
15 ...	291	+52	Swift; small.	30 ...	190	+58	Swift; streaks.
15 ...	285	+23	Slowish.	Dec. 4 ...	162	+58	Swift; streaks.
20 ...	335	+57	Swift.	4 ...	110	+25	Slowish.
28 ...	294	+39	Slow.	6 ...	80	+23	Slow; bright.
July 4 ...	303	+24	Swift.	8 ...	145	+ 7	Swift; streaks.
7 ...	333	+26	Swift.	8 ...	208	+71	Rather swift.
19 ...	314	+48	Swift; short.	10 ...	**108**	**+33**	Swift; short.
20 ...	269	+49	Swift.	12 ...	119	+29	Rather swift.
22 ...	16	+31	Swift; streaks.	22 ...	194	+67	Swift; streaks.
25 ...	48	+43	Swift; streaks.	25 ...	98	+31	Very slow.

The radiant-points of the more brilliant showers are indicated by heavier type.

The Perseids, with max. on August 10, are visible for a considerable period and their radiant-point exhibits an easterly motion amongst the stars. The following is an ephemeris:—

Date.	Radiant.		Date.	Radiant.		Date.	Radiant.	
	a	*δ*		*a*	*δ*		*a*	*δ*
July 19 ...	19°	+51°	July 29 ...	32°	+54°	Aug. 8 ...	42°	+57°
21 ...	22	+52	31 ...	34	+55	10 ...	45	+57
23 ...	25	+52	Aug. 2 ...	36	+55	12 ...	47	+57
25 ...	27	+53	4 ...	38	+56	14 ...	50	+58
27 ...	30	+54	6 ...	40	+56	16 ...	53	+58

1896.	**Mercury (☿).**						**Venus (♀).**						**Mars (♂).**					
	R.A. Noon.	Dec. Noon.	Diam.	Rises.	Transits.	Sets.	R.A. Noon.	Dec. Noon.	Diam.	Rises.	Transits.	Sets.	R.A. Noon.	Dec. Noon.	Diam.	Rises.	Transits.	Sets.
	h m s	° ′	″	h m	h m	h m	h m s	° ′	″	h m	h m	h m	h m s	° ′	″	h m	h m	h m
Jan. 2...	19 24 31	24 11 S.	4·8	20 49	0 38	4 28	15 44 0	17 6 S.	18·0	16 24	20 58	1 32	16 55 21	22 50 S.	4·0	18 11	22 8	2 5
12...	20 33 59	20 40	5·4	20 57	1 8	5 20	16 32 10	19 33	16·8	16 48	21 7	1 26	17 26 34	23 33	4·2	18 8	22 0	1 52
22...	21 31 42	15 7	6·6	20 42	1 26	6 10	17 22 19	21 14	15·6	17 10	21 18	1 26	17 58 19	23 53	4·2	18 2	21 52	1 42
Feb. 1...	21 48 49	10 51	8·8	19 55	1 3	6 11	18 13 49	21 59	14·8	17 27	21 30	1 33	18 30 24	23 49	4·4	17 55	21 45	1 35
11...	21 10 42	12 26	10·4	18 38	23 38	4 38	19 5 56	21 42	14·0	17 36	21 42	1 47	19 2 36	23 21	4·4	17 44	21 37	1 31
21...	20 49 41	15 34	9·0	18 0	22 42	3 24	19 57 44	20 22	13·4	17 42	21 55	2 8	19 34 42	22 28	4·6	17 30	21 30	1 30
Mar. 2...	21 11 16	16 11	7·4	17 49	22 28	3 7	20 48 28	18 3	12·8	17 37	22 6	2 35	20 6 31	21 12	4·6	17 14	21 23	1 32
12...	21 55 8	14 13	6·4	17 44	22 34	3 24	21 37 44	14 52	12·2	17 29	22 16	3 3	20 37 55	19 34	4·8	16 56	21 15	1 35
22...	22 49 11	9 56	5·8	17 36	22 49	4 2	22 25 25	11 0	11·8	17 16	22 24	3 32	21 8 46	17 37	5·0	16 35	21 6	1 38
Apr. 1...	23 49 36	3 37 S.	5·2	17 24	23 10	4 58	23 11 45	6 38	11·4	17 1	22 31	4 2	21 39 1	15 22	5·2	16 13	20 57	1 41
11...	0 56 58	4 27 N.	5·0	17 13	23 39	6 5	23 57 10	1 58 S.	11·0	16 42	22 37	4 35	22 8 40	12 54	5·2	15 50	20 47	1 44
21...	2 13 18	13 26	5·2	16 58	0 13	7 28	0 42 15	2 51 N.	10·8	16 28	22 43	5 3	22 37 43	10 13	5·4	15 25	20 37	1 48
May 1...	3 33 46	20 58	5·8	16 53	0 54	8 55	1 27 37	7 35	10·4	16 6	22 49	5 34	23 6 16	7 24	5·6	14 59	20 26	1 52
11...	4 42 9	24 44	7·2	16 56	1 23	9 50	2 13 55	12 3	10·2	15 49	22 56	6 5	23 34 21	4 30	5·8	14 32	20 14	1 56
21...	5 25 5	24 57	9·0	17 0	1 26	9 56	3 1 40	16 3	10·0	15 35	23 4	6 35	0 2 5	1 34 S.	6·0	14 6	20 3	2 0
31...	5 35 26	22 52	11·2	16 45	0 57	9 9	3 51 10	19 24	10·0	15 23	23 14	7 6	0 29 31	1 21 N.	6·2	13 40	19 51	2 2
June 10...	5 18 7	19 53	12·2	16 8 16 4	0 1 23 54	7 52 7 45	4 42 31	21 53	9·8	15 20	23 26	7 36	0 56 45	4 13	6·4	13 12	19 38	2 4
20...	5 1 15	18 15	10·8	14 49	23 0	6 41	5 35 20	23 22	9·8	15 22	23 40	7 59	1 23 48	6 58	6·6	12 47	19 26	2 6
30..	5 11 22	19 18	8·6	14 49	22 34	6 19	6 28 55	23 43	9·6	15 33	23 54	8 15	1 50 43	9 35	7·0	12 21	19 14	2 8
July 10...	5 54 35	21 45	6·8	14 35	22 41	6 47	7 22 22	22 53	9·6	15 52	0 7	8 22	2 17 28	12 0	7·2	11 55	19 1	2 8
20...	7 8 16	22 56	5·6	15 3	23 17	7 33	8 14 49	20 57	9·8	16 19	0 20	8 21	2 44 0	14 13	7·6	11 30	18 48	2 7
30...	8 36 42	20 17	5·0	16 5	0 2	7 59	9 5 37	18 1	9·8	16 48	0 31	8 12	3 10 12	16 10	7·8	11 5	18 35	2 5
Aug. 9...	9 56 50	14 15	5·0	17 23	0 43	8 1	9 54 33	14 14	9·8	17 21	0 41	8 0	3 35 53	17 53	8·2	10 41	18 21	2 1
19...	11 2 41	6 58 N.	5·2	18 29	1 9	7 49	10 41 43	9 49	10·0	17 52	0 48	7 43	4 0 49	19 19	8·6	10 16	18 6	1 56
29...	11 57 17	0 16 S.	5·8	19 21	1 24	7 27	11 27 33	4 58 N.	10·2	18 25	0 55	7 22	4 24 41	20 30	9·2	9 53	17 51	1 49
Sept. 8...	12 42 40	6 43	6·4	20 1	1 30	7 0	12 12 39	0 8 S.	10·4	18 55	1 1	7 5	4 47 7	21 26	9·8	9 30	17 34	1 38
18...	13 16 8	11 32	7·6	20 0	1 24	6 28	12 57 42	5 15	10·6	19 26	1 6	6 45	5 7 34	22 10	10·4	9 6	17 15	1 24
28...	13 25 56	13 1	9·2	20 0	0 55	5 51	13 43 23	10 12	10·8	19 58	1 12	6 25	5 25 33	22 44	11·2	8 40	16 53	1 6
Oct. 8...	12 57 41	8 17	10·0	18 20	23 39	4 59	14 30 23	14 47	11·2	20 32	1 20	6 8	5 40 18	23 12	12·0	8 12	16 28	0 44
18...	12 37 5	2 45	8·2	16 57	22 44	4 33	15 19 10	18 46	11·6	21 4	1 29	5 54	5 50 59	23 37	13·0	7 41	15 59	0 17
28...	13 9 45	5 6	6·2	17 2	22 41	4 19	16 9 57	21 57	11·8	21 35	1 41	5 48	5 56 42	24 2	14·0	7 4	15 25	23 46
Nov. 7...	14 5 57	11 7	5·2	17 51	22 59	4 6	17 2 34	24 7	12·4	22 4	1 54	5 44	5 56 32	24 29	15·0	6 21	14 45	23 9
17...	15 7 39	17 5	4·8	18 47	23 22	3 54	17 56 21	25 7	12·8	22 25	2 8	5 51	5 49 57	24 58	16·0	5 32	13 59	22 26
27...	16 12 5	21 47	4·6	19 41	23 47	3 52	18 50 16	24 54	13·4	22 38	2 23	6 8	5 37 28	25 24	16·6	4 37	13 7	21 37
Dec. 7...	17 19 24	24 42	4·6	20 27	0 12	3 57	19 43 12	23 26	14·2	22 41	2 36	6 32	5 21 0	25 38	16·6	3 40	12 11	20 42
17...	18 28 56	25 26	5·0	21 1	0 42	4 23	20 34 11	20 52	15·0	22 36	2 48	6 59	5 3 59	25 38	16·2	2 43	11 15	19 47
27...	19 37 13	23 40 S.	5·4	21 23	1 11	5 3	21 22 38	17 22 S.	15·8	22 21	2 57	7 32	4 49 57	25 29 N.	15·2	1 51	10 22	18 53

Mercury.

	d h	d h	d h
Gr. elong. E....	Jan. 23 19;	May 16 4;	Sept. 12 17
„ W....	Mar. 5 4;	July 4 0;	Oct. 23 20
Sup. conj.	Apr. 17 17;	July 31 5;	Nov. 28 6
Inf. conj.	Feb. 8 6;	June 10 2;	Oct. 8 8
Stationary ...	Jan. 29 19;	Feb. 20 6;	May 29 1

Venus.

d h
Sup. conj. ....July 9 1

Superior Planets.

	Conjunction. d h	Opposition. d h	Quadrature. d h d h	Stationary. d h d h
Mars ...	......	Dec. 10 18	Aug. 31 19	Nov. 1 19
Jupiter ...	Aug. 11 21	Jan. 24 2	Apr. 19 5; Nov. 30 11	Mar. 24 13; Dec. 25 13
Saturn ...	Nov. 13 2	May 5 9	Feb. 7 13; Aug. 4 5	Feb. 27 0; July 16 5
Uranus ...	Nov. 16 3	May 12 7	Feb. 13 2; Aug. 12 7	Feb. 27 9; July 28 16

Jupiter (♃). Saturn (♄).

1896.	R.A. Noon.	Dec. Noon.	Diam.	Rises.	Transits.	Sets.	R.A. Noon.	Dec. Noon.	Diam.	Rises.	Transits.	Sets.
	h m s	° ′	″	h m	h m	h m	h m s	° ′	″	h m	h m	h m
Jan. 1	8 38 21	19 7 N.	41·6	6 5	13 53	21 41	14 58 50	14 39 S.	14·8	15 26	20 13	1 0
21	8 28 12	19 47	42·4	4 31	12 24	20 17	15 4 44	15 0	15·2	14 15	19 0	23 45
Feb. 10	8 17 29	20 25	41·8	2 59	10 55	18 52	15 8 21	15 11	15·8	13 1	17 45	22 29
Mar. 1	8 9 16	20 52	40·4	1 29	9 28	17 27	15 9 18	15 10	16·2	11 43	16 27	21 11
21	8 5 40	21 3	38·2	0 6	8 6	16 6	15 7 34	14 59	16·8	10 22	15 7	19 52
Apr. 10	8 7 22	20 57	36·0	22 49	6 49	14 49	15 3 32	14 40	17·2	8 57	13 44	18 31
30	8 13 57	20 36	33·8	21 39	5 37	13 34	14 58 0	14 15	17·4	7 31	12 20	17 9
May 20	8 24 30	20 1	32·0	20 35	4 29	12 23	14 52 7	13 50	17·2	6 3	10 55	15 47
June 9	8 38 1	19 13	30·6	19 35	3 24	11 13	14 47 4	13 31	17·0	4 39	9 32	14 25
29	8 53 33	18 13	29·6	18 39	2 21	10 3	14 43 48	13 21	16·6	3 16	8 10	13 4
July 19	9 10 18	17 3	29·0	17 44	1 19	8 54	14 42 53	13 22	16·0	1 56	6 50	11 44
Aug. 8	9 27 33	15 45	28·6	16 50	0 17	7 44	14 44 3	13 35	15·4	0 40	5 33	10 26
28	9 44 42	14 22	28·8	15 54	23 13	6 32	14 48 32	13 58	15·0	23 28	4 19	9 10
Sept. 17	10 1 9	12 58	29·2	14 59	22 11	5 21	14 54 38	14 30	14·6	22 18	3 6	7 54
Oct. 7	10 16 17	11 37	30·0	14 2	21 7	4 10	15 2 24	15 6	14·4	21 11	1 55	6 39
27	10 29 24	10 26	31·4	13 4	20 1	2 58	15 11 19	15 45	14·2	20 4	0 46	5 26
Nov. 16	10 39 44	9 30	33·0	12 0	18 53	1 44	15 20 50	16 23	14·0	18 55	23 33	4 11
Dec. 6	10 46 25	8 55	35·0	10 51	17 40	0 29	15 30 20	16 58	14·2	17 50	22 24	2 58
26	10 48 42	8 47 N.	37·2	9 36	16 24	23 12	15 39 12	17 28 S.	14·4	16 43	21 14	1 45

Uranus (♅). Neptune (♆).

Jan. 1	15 23 1	18 17 S.	3·5	16 11	20 37	1 3	4 59 53	21 15 N.	2·7	2 13	10 15	18 17
31	15 27 28	18 33	3·6	14 18	18 43	23 8	4 57 20	21 12	2·7	0 14	8 15	16 16
Mar. 1	15 28 51	18 37	3·6	12 23	16 47	21 11	4 56 40	21 13	2·7	22 14	6 16	14 18
31	15 26 59	18 31	3·8	10 27	14 47	19 17	4 58 9	21 17	2·6	20 18	4 20	12 22
Apr. 30	15 22 44	18 15	3·8	8 18	12 44	17 16	5 1 28	21 23	2·6	18 23	2 25	10 27
May 30	15 17 42	17 56	3·8	6 13	10 41	15 9	5 5 56	21 30	2·5	16 27	0 31	8 35
June 29	15 13 45	17 42	3·8	4 10	8 40	13 10	5 10 40	21 36	2·5	14 29	22 34	6 39
July 29	15 12 17	17 37	3·8	2 10	6 40	11 10	5 14 48	21 40	2·5	12 36	20 41	4 46
Aug. 28	15 13 52	17 44	3·6	0 14	4 44	9 14	5 17 30	21 42	2·6	10 4	18 45	2 50
Sept. 27	15 18 22	18 2	3·6	22 22	2 50	7 18	5 18 14	21 41	2·6	8 43	16 48	0 53
Oct. 27	15 24 57	18 27	3·5	20 34	0 59	5 24	5 16 53	21 38	2·7	6 45	14 49	22 53
Nov. 26	15 32 29	18 54	3·4	18 42	23 5	3 28	5 13 51	21 35	2·7	4 44	12 48	20 52
Dec. 26	15 39 37	19 18 S.	3·4	16 54	21 14	1 34	5 10 18	21 31 N.	2·7	2 42	10 46	18 50

Ceres. Pallas.

1896.	R.A. Noon.	Dec. Noon.	Transits.	1896.	R.A. Noon.	Dec. Noon.	Transits.
	h m	° ′	h m		h m	° ′	h m
Aug. 19 ...	0 45	11 21 S.	14 49	July 2 ...	21 43	14 39 N.	14 56
Sept. 12 ...	0 32	13 46	13 1	26 ...	21 30	13 38	13 9
Oct. 6 ...	0 12	15 32	11 7	Aug. 19 ...	21 12	10 25	11 16
30 ...	23 57	15 33	9 18	Sept. 12 ...	20 57	5 43	9 27
Nov. 23 ...	23 53	13 48	7 40	Oct. 6 ...	20 52	0 59 N.	7 48
Dec. 17 ...	0 2	10 52 S.	6 15	30 ...	20 58	2 41 S.	6 20

Juno. Vesta.

Nov. 11 ...	6 10	1 31 N.	14 43	Nov. 11 ...	6 35	19 22 N.	15 8
Dec. 5 ...	5 58	0 51 S.	12 57	Dec. 5 ...	6 20	20 7	13 18
29 ...	5 38	0 17 S.	11 2	29 ...	5 54	21 12 N.	11 18

The times of rising and setting correspond to the adjacent transit, irrespective of the day given in *the first column.*

ECLIPSES IN 1896.

In the year 1896 there will be two Eclipses of the Sun and two of the Moon.

I.—*An Annular Eclipse of the Sun, February* 13.

Invisible at Greenwich.

The path of the annulus during the Eclipse lies wholly in the South Atlantic and Antarctic Oceans, and is therefore of little interest. The Eclipse will be seen as Partial at the Cape of Good Hope. The Eclipse begins at $5^h\ 33^m$ Cape Mean Time, at the point of the limb 127° W. from the North Point. The greatest phase is at $6^h\ 38^m$, and the Sun sets at $6^h\ 54^m$ Cape Mean Time. Magnitude of the Eclipse at the Cape 0·849 (Sun's diam. = 1).

II.—*A Partial Eclipse of the Moon, February* 28.

Partly visible at Greenwich. The first contact with the shadow occurs at 85° from the North Point towards the East. Last contact 30° towards the West.

	h	m		h	m
First contact with Penumbra ……	5	15·5	With Shadow	6	16·3
Last contact with Penumbra ………	10	15·9	With Shadow	9	15·1

At Greenwich the Moon will rise at $5^h\ 27^m$.

Magnitude of the Eclipse 0·870 (Moon's diam. = 1).

III.—*A Total Eclipse of the Sun, August* 8.

Invisible at Greenwich. Visible over the whole of Europe and Asia, excluding England, Ireland, France, Spain and Portugal, Arabia, Persia, India, and Further India and Southern China. The line of Central Eclipse passes through the North of Norway, Nova Zembla, Siberia, and Japan. The end of the Eclipse is visible at Edinburgh and throughout Scotland at about sunrise.

The central line across Norway runs 15 miles south of Bodö and 5 miles south of Vadsö. The duration of Totality and altitude of Sun are 88^{sec} and 7°, 100^{sec} and 14°, at Bodö and Vadsö respectively. The North limit of Totality runs just south of the Lofoden Islands and through Tana; the South limit from Alstahoug and the Seven Sisters to the middle of the Ribachi peninsula (*v.* Obs. vol. xvii. p. 323).

Greenwich M.T. of ☌ in R.A.: Aug. $8^d\ 16^h\ 37^m\ 23^s{\cdot}0$.

☉'s and ☾'s R.A. $9^h\ 17^m\ 57^s{\cdot}67$. Hourly motions $9^s{\cdot}51$ and $137^s{\cdot}96$.

	°	′	″		′	″
☉'s Declination …………	15	44	22·9 N.	Hourly motion ……	0	43·6 S.
☾'s Declination …………	16	29	18·1 N.	Hourly motion ……	13	56·0 S.
☉'s Equat. Hor. Parallax		0	8·7	True Semidiameter…	15	48·4
☾'s Equat. Hor. Parallax		59	28·0	True Semidiameter …	16	13·9

	Aug. 8.		In Long.			Lat.		
	h	m	°	′		°	′	
Eclipse begins ………………	14	43·4	32	30	E.	47	49	N.
Central Eclipse begins ……	15	53·1	0	3	W.	62	52	N.
Central Eclipse at noon ……	16	37·4	111	58	E.	65	13	N.
Central Eclipse ends ………	18	25·2	179	3	W.	20	17	N.
Eclipse ends …………………	19	34·9	158	36	E.	3	34	N.

IV.—*A Partial Eclipse of the Moon, August* 22.

Partly visible as a penumbral Eclipse at Greenwich. The first contact with the shadow occurs at 100° from the North Point of the limb towards the East. The last contact 153° towards the West.

	h	m		h	m
First contact with Penumbra……	16	8·1	With Shadow .	17	24·4
Second contact with Penumbra…	21	46·9	With Shadow .	20	30·6

Magnitude of Eclipse 0·734 (Moon's diameter = 1).

At Greenwich the Moon will set at $16^h\ 58^m$.

OCCULTATIONS, 1896. (VISIBLE AT GREENWICH.)

te.	Star.	Mag.	Disap.		Reap.	
			M.T.	P.	M.T.	P.
n.			h m	°	h m	°
	D.M.+23° 1866	6·5	10 38	67	11 34	324
	χ Virginis	4·7	15 24	83	16 14	350
	B.A.C. 1648	6·5	7 13	41	8 10	304
	B.A.C. 2991	6·5	18 46	156	19 22	251
	ψ Leonis	5·7	16 25	95	17 18	327
b.						
	υ Leonis	4·5	19 47	194	20 3	226
	τ Sagittarii	3·5	18 54	106	20 6	241
	D.M.+23° 1866	6·5	7 58	75	8 59	322
	μ^1 Cancri	6·2	11 34	188	11 53	220
	ν Leonis	5·3	8 36	177	9 11	240
r.						
	B.A.C. 4312	6·5	13 53	167	14 45	265
	83 Virginis	5·8	12 5	124	13 11	303
	B.A.C. 5603	6·4	14 9†	127	15 13	264
	18 Tauri	6·3	7 42	63	8 46	281
	136 Tauri	4·5	14 44†	28	15 2†	343
	B.A.C. 2991	6·5	15 54	142	16 35†	262
	ψ Leonis	5·7	14 38	55	15 2	2
	79 Leonis	5·5	9 58	160	10 55	274
	υ Leonis	4·5	17 17†	174	17 46†	241
r.						
	Mars	...	22 15	105	23 5	181
	A Geminorum	5·0	10 11	82	11 3	316
	B.A.C. 4312	6·5	12 3	137	13 8	288
	83 Virginis	5·8	9 53	115	11 1	311
	4 Scorpii	5·5	14 57	27	15 15	358
	B.A.C. 6072	5·8	12 10	76	13 18	293
y						
	52 Geminorum	6·3	11 51‡	112	12 38†	275
	7 Cancri	6·3	9 25	185	9 43	220
	υ Leonis	4·5	10 47	125	11 49	301
	B.A.C. 7049	6·0	12 29	126	13 13	198
	30 Capricorni	5·5	11 11†	100	12 9*	223
ne						
	14 Piscium	5·9	13 25	3	13 58	299
	82 Geminorum	6·5	8 15	93	9 5	306
	Jupiter	...	9 52	113	10 43	293
	48 Leonis	5·2	11 8	119	12 0†	295
	76 Leonis	6·5	7 45	68	8 21	2
	4 Scorpii	5·5	8 57	47	9 34	347
	B.A.C. 6127	4·7	11 56	55	13 4	293
	μ Capricorni	5·2	15 35	23	16 41	267
	B.A.C. 8094	5·6	10 59	17	11 43	288
y						
	ε Arietis	4·6	11 34†	85	12 23	235
	τ Scorpii	2·9	7 13	136	8 17	249
	B.A.C. 5603	6·4	12 14†	167	12 29†	194
	21 Piscium	6·1	15 10	94	16 9	190
	51 Piscium	5·7	15 35	40	16 53	245

Date.	Star.	Mag.	Disap.		Re
			M.T.	P.	M.T.
Aug.			h m	°	h m
18	B.A.C. 6220	6·5	6 22	90	7 40
24	11 Piscium	6·5	10 31	96	11 28
28	26 Arietis	6·1	14 16	19	15 16
Sept.					
2	40 Geminorum	6·5	12 40	29	13 4
14	B.A.C. 6127	4·7	7 10	52	8 17
17	20 Capricorni	6·2	10 29	42	11 40
18	45 Capricorni	5·8	7 44	55	9 2
18	μ Capricorni	5·2	14 19	124	14 45
20	B.A.C. 8094	5·6	9 32	75	10 45
26	16 Tauri	6·5	7 55	68	8 49
26	17 Tauri	3·8	7 56	110	8 39
26	19 Tauri	4·4	8 16	32	8 58
26	20 Tauri	4·0	8 21	66	9 17
Oct.					
1	ε Cancri	6·5	16 40	115	17 52
3	44 Leonis	6·2	15 27	40	15 42
18	25 Piscium	6·3	14 43	49	15 43
19	51 Piscium	5·7	12 13	65	13 28
22	μ Arietis	5·8	7 45	115	8 26
23	19 Tauri	4·4	15 43	105	16 53
23	20 Tauri	4·0	16 22	146	16 53
24	χ^1 Tauri	5·5	7 3	96	7 55
27	52 Geminorum	6·3	10 10	66	11 2
28	μ^2 Cancri	5·3	9 41	115	10 32
28	B.A.C. 2788	5·9	16 2	148	17 4
30	A Leonis	4·6	17 57	184	18 31
31	*d* Leonis	5·0	18 7	138	19 15
Nov.					
11	D.M.−17° 6216	6·4	6 40	87	7 44
14	12 Piscium	6·5	6 20	8	7 14
23	37 Geminorum	6·2	7 23	71	8 14
24	7 Cancri	6·3	14 23	53	15 5
24	μ^2 Cancri	5·3	16 45	84	17 48
27	48 Leonis	5·2	12 36	90	13 30
Dec.					
7	B.A.C. 6814	6·4	3 25	120	4 9
8	D.M.−19° 5950	6·5	5 47	102	6 37
9	42 Capricorni	5·3	4 36	22	5 39
17	20 Tauri	4·0	3 30	37	4 17
17	η Tauri	3·0	4 14	136	4 38
18	D.M.+26° 783	6·5	17 25	161	17 47
20	37 Geminorum	6·2	15 23	79	16 23
22	δ Cancri	4·3	15 31	147	16 35
30	4 Scorpii	5·5	17 38*	104	18 44

*** Star rising. ‡ Star setting. † Star below horizon.**

***The angles (P) are reckoned* from the true N. point in the direction N., E., S., W., *i. e.* from the *bottom of the* Moon's inverted image towards the right.**

The following "near approaches" are also given in the 'Nautical Almanac,' and are especially interesting to observers rather South and rather North of Greenwich respectively:—

North Near Approaches.

Date.	Star.	Mag.	G.M.T.	Angle.	Date.	Star.	Mag.	G.M.T.	Angle.
Jan.			h m	°	Sept.			h m	°
1	κ Geminor...	3·6	4 19	7	2	39 Geminor.	6·5	12 39	2
19	14 Piscium ..	5·9	6 6	323	Oct.				
28	κ Geminor...	3·6	16 40	21	1	η Cancri......	5·5	13 20	13
Mar.					17	B.A.C. 8017.	6·0	8 59	323
23	κ Geminor...	3·6	12 21	21	23	18 Tauri......	6·3	16 26	350
May					Nov.				
19	23 Leonis ...	6·5	8 46	33	13	67 Aquarii...	6·2	4 25	329
June					18	26 Arietis ...	6·1	9 47	331
27	20 Capricorni	6·2	12 44	336	23	52 Geminor.	6·3	18 1	20
Aug.					Dec.				
21	D.M.–17°6216	6·4	12 55	328	17	19 Tauri ...	4·4	3 41	341

South Near Approaches.

Jan.			h m	°	Sept.			h m	°
1	μ^1 Cancri ...	6·2	14 19	202	25	ε Arietis......	4·6	10 28	154
3	ν Leonis......	5·3	12 38	208	26	η Tauri	3·0	9 23	160
28	A Geminor...	5·0	6 28	186	Oct.				
Feb.					18	21 Piscium...	6·1	12 18	145
1	79 Leonis ...	5·5	12 16	215	23	16 Tauri......	6·5	15 59	169
23	136 Tauri ...	4·5	5 55	177	Nov.				
28	37 Sextantis.	6·2	5 22	204	20	χ' Tauri	5·5	15 23	177
Mar.					21	D.M.+26°783	6·5	8 31	168
18	ε Arietis......	4·6	10 36	169	25	δ Cancri......	4·3	8 51	193
19	19 Tauri......	4·4	8 10	172	Dec.				
Aug.					9	44 Capricorni	5·8	5 32	146
1	μ Arietis ...	5·8	11 48	155	16	ε Arietis......	4·6	5 53	154
Sept.					17	23 Tauri ...	4·2	3 53	161
2	37 Geminor.	6·2	11 26	182	17	28 Tauri ...	6·2	5 16	160
3	7 Cancri......	6·3	15 40	190					

The following stars will be occulted at Greenwich during the Partial Lunar Eclipse of Feb. 28:—

Star.	Mag.	Dis. or Reapp^{ce}.	G. M. T.	Angle.
			h m	°
B.D.+7°2373	9·3	D.	6 42	81
B.D.+6°2364	8·8	D.	7 6	147
B.D.+7°2370	9·5	R.	7 7	325
B.D.+7°2373	9·3	R.	7 28	334
B.D.+7°2364	8·8	R.	7 56	270

The occultation of a 9th mag. star by Jupiter will be observable in North America, except in the Western States, on May 22. The apparent place of the star is $8^{h}\ 26^{m}\ 9^{s}{\cdot}4$, $+19^{\circ}\ 55'\ 33''{\cdot}7$, and it will be occulted by Jupiter (geocentrically) from $15^{h}\ 8^{m}$ to $16^{h}\ 28^{m}$ G. M. T.

SATELLITES OF MARS

DURING THE OPPOSITION OF 1896.

East Elongations.

Phobos.

November.		Nov. (*con.*).		Nov. (*con.*).		Dec. (*con.*).		Dec. (*con.*).		Dec. (*con.*).	
d	h	d	h	d	h	d	h	d	h	d	h
13	4·0	21	18·6	30	9·3	7	9·6	16	0·1	24	14·8
	11·6	22	2·3		16·9		17·2		7·8		22·4
	19·3		9·9			8	0·8		15·5	25	6·1
14	2·9		17·6				8·5		23·1		13·8
	10·6	23	1·2				16·1	17	6·8		21·4
	18·2		8·9	December.			23·8		14·4	26	5·1
15	1·9		16·5			9	7·4		22·1		12·7
	9·6	24	0·2	1	0·6		15·1	18	5·7		20·4
	17·2		7·9		8·2		22·8		13·4	27	4·0
16	0·9		15·5		15·9	10	6·4		21·0		11·7
	8·5		23·2		23·5		14·1	19	4·7		19·3
	16·2	25	6·8	2	7·2		21·7		12·3	28	3·0
	23·8		14·5		14·8	11	5·4		20·0		10·6
17	7·5		22·1		22·5		13·0	20	3·6		18·3
	15·2	26	5·8	3	6·1		20·7		11·3	29	1·9
	22·8		13·4		13·7	12	4·4		18·9		9·6
18	6·5		21·0		21·4		12·0	21	2·6		17·2
	14·1	27	4·7	4	5·0		19·7		10·2	30	0·9
	21·8		12·3		12·7	13	3·3		17·9		8·5
19	5·4		20·0		20·3		11·0	22	1·5		16·2
	13·1	28	3·6	5	4·0		18·6		9·2		23·8
	20·7		11·3		11·7	14	2·3		16·8	31	7·5
20	4·3		19·0		19·3		9·9	23	0·5		15·1
	12·0	29	2·6	6	3·0		17·5		8·2		22·8
	19·6		10·3		10·6	15	1·2		15·8		
21	3·2		17·9		18·3		8·8		23·5		
	10·9	30	1·6	7	1·9		16·5	24	7·1		

Deimos.

November.		Nov. (*con.*).		Nov. (*con.*).		December.		Dec. (*con.*).		Dec. (*con.*).	
d	h	d	h	d	h	d	h	d	h	d	h
8	1·9	18	4·1	28	6·2	2	1·0	12	3·1	22	5·3
9	8·2	19	10·3	29	12·5	3	7·3	13	9·4	23	11·5
10	14·5	20	16·6	30	18·7	4	13·5	14	15·7	24	17·8
11	20·7	21	22·9			5	19·8	15	21·9	26	0·1
13	3·0	23	5·1			7	2·1	17	4·2	27	6·3
14	9·3	24	11·4			8	8·3	18	10·5	28	12·6
15	15·5	25	17·7			9	14·6	19	16·7	29	18·9
16	21·8	26	23·9			10	20·9	20	23·0	31	1·1

Apparent Disk of Mars, 1896.

Jan. 1	0·985	May 30	0·878	Sept. 27	0·870
31	0·962	June 29	0·862	Oct. 27	0·920
Mar. 1	0·943	July 29	0·852	Nov. 26	0·986
31	0·921	Aug. 28	0·852	Dec. 26	0·987
April 30	0·898				

The numbers in this table are the versed sines of the illuminated disk, the apparent diameter of the planet being taken as unity.

JUPITER'S SATELLITES, 1896.

Phenomena.

e, Signifies Ec. dis.; E, Ec. re.; *o*, Occ. dis.; O, Occ. re.; *t*, Tr. Ing.; T, Tr. Egr.

January.

d	h	m	
1	8	7	i. *e*.
	10	57	i. O.
	16	0	ii. *e*.
	19	58	ii. O.
2	5	56	i. *t*.
	8	16	i. T.
3	2	35	i. *e*.
	5	23	i. O.
	11	9	ii. *t*.
	14	5	ii. T.
	19	42	iv. *e*.
4	0	7	iv. E.
	0	16	iv. *o*.
	0	22	i. *t*.
	2	42	i. T.
	4	19	iii. *t*.
	4	59	iv. O.
	7	59	iii. T.
	21	3	i. *e*.
	23	49	i. O.
5	5	18	ii. *e*.
	9	6	ii. O.
	18	48	i. *t*.
	21	8	i. T.
6	15	32	i. *e*.
	18	15	i. O.
7	0	16	ii. *t*.
	3	12	ii. T.
	13	14	i. *t*.
	15	34	i. T.
	16	17	iii. *e*.
	21	29	iii. O.
8	10	0	i. *e*.
	12	41	i. O.
	18	35	ii. *e*.
	22	14	ii. O.
9	7	41	i. *t*.
	10	1	i. T.
10	4	29	i. *e*.
	7	7	i. O.
	13	24	ii. *t*.
	16	19	ii. T.
11	2	6	i. *t*.
	4	26	i. T.
	7	36	iii. *t*.
	11	15	iii. T.
	22	57	i. *e*.
12	1	33	i. O.
	6	43	iv. *t*.
	7	53	ii. *e*.
	11	21	ii. O.
	11	26	iv. T.
	20	32	i. *t*.
	22	53	i. T.

Jan. (con.).

d	h	m	
13	17	26	i. *e*.
	19	59	i. O.
14	2	31	ii. *t*.
	5	26	ii. T.
	14	58	i. *t*.
	17	19	i. T.
	20	17	iii. *e*.
15	0	46	iii. O.
	11	54	i. *e*.
	14	25	i. O.
	21	11	ii *e*.
16	0	28	ii. O.
	9	24	i. *t*.
	11	45	i. T.
17	6	23	i. *e*.
	8	51	i. O.
	15	38	ii. *t*.
	18	33	ii. T.
18	3	50	i. *t*.
	6	11	i. T.
	10	51	iii. *t*.
	14	31	iii. T.
19	0	51	i. *e*.
	3	17	i. O.
	10	29	ii. *e*.
	13	36	ii. O.
	22	16	i. *t*.
20	0	36	i. T.
	13	43	iv. *e*.
	19	8	iv. O.
	19	20	i. *e*.
	21	43	i. O.
21	4	44	ii. *t*,
	7	39	ii. T.
	16	42	i. *t*.
	19	2	i. T.
22	0	15	iii. *e*.
	4	2	iii. O.
	13	48	i. *e*.
	16	9	i. O.
	23	47	ii. *e*.
23	2	43	ii. O.
	11	8	i. *t*.
	13	28	i. T.
24	8	14	i. *o*.
	10	34	i. O.
	17	51	ii. *t*.
	20	46	ii. T.
25	5	34	i. *t*.
	7	54	i. T.
	14	7	iii. *t*.
	17	47	iii. T.
26	2	40	i. *o*.
	5	1	i. E.

Jan. (con.).

d	h	m	
26	12	54	ii. *o*.
	15	55	ii. E.
27	0	0	i. *t*.
	2	20	i. T.
	21	6	i. *o*.
	23	30	i. E.
28	6	58	ii. *t*.
	9	53	ii. T.
	18	25	i. *t*.
	20	46	i. T.
	20	48	iv. *t*.
29	1	31	iv. T.
	3	37	iii. *o*.
	7	43	iii. E.
	15	32	i. *o*.
	17	58	i. E.
30	2	1	ii. *o*.
	5	12	ii. E.
	12	51	i. *t*.
	15	12	i. T.
31	9	58	i. *o*.
	12	27	i. E.
	20	5	ii. *t*.
	23	0	ii. T.

February.

d	h	m	
1	7	17	i. *t*.
	9	38	i. T.
	17	24	iii. *t*.
	21	3	iii. T.
2	4	24	i. *o*.
	6	55	i. E.
	15	9	ii. *o*.
	18	30	ii. E.
3	1	43	i. *t*.
	4	3	i. T.
	22	50	i. *o*.
4	1	24	i. E.
	9	12	ii. *t*.
	12	8	ii. T.
	20	9	i. *t*.
	22	29	i. T.
5	6	53	iii. *o*.
	11	42	iii. E.
	17	16	i. *o*.
	19	53	i. E.
6	4	16	ii. *o*.
	4	31	iv. *o*.
	7	48	ii. E.
	12	17	iv. E.
	14	35	i. *t*.
	16	55	i. T.
7	11	42	i. *o*.

Feb. (con.).

d	h	m	
7	14	21	i. E.
	22	20	ii. *t*.
8	1	15	ii. T.
	9	1	i. *t*.
	11	21	i. T.
	20	41	iii. *t*.
9	0	20	iii. T.
	6	8	i. *o*.
	8	50	i. E.
	17	24	ii. *o*.
	21	6	ii. E.
10	3	28	i. *t*.
	5	48	i. T.
11	0	34	i. *o*.
	3	19	i. E.
	11	28	ii. *t*.
	14	23	ii. T.
	21	54	i. *t*.
12	0	14	i. T.
	10	12	iii. *o*.
	15	42	iii. E.
	19	0	i. *o*.
	21	47	i. E.
13	6	32	ii. *o*.
	10	24	ii. E.
	16	20	i. *t*.
	18	40	i. T.
14	11	3	iv. *t*.
	13	27	i. *o*.
	15	44	iv. T.
	16	16	i. E.
15	0	37	ii. *t*.
	3	32	ii. T.
	10	46	i. *t*.
	13	6	i. T.
16	0	0	iii. *t*.
	3	39	iii. T.
	7	53	i. *o*.
	10	45	i. E.
	19	40	ii. *o*.
	23	41	ii. E.
17	5	12	i. *t*.
	7	32	i. T.
18	2	19	i. *o*.
	5	13	i. E.
	13	45	ii. *t*.
	16	40	ii. T.
	23	39	i. *t*.
19	1	59	i. T.
	13	33	iii. *o*.
	19	42	iii. E.
	20	46	i. *o*.
	23	42	i. E.
20	8	49	ii. *o*.

Feb. (con.).

d	h	m	
20	12	59	ii. E.
	18	5	i. *t*.
	20	25	i. T.
21	15	12	i. *o*.
	18	11	i. E.
22	2	55	ii. *t*.
	5	50	ii. T.
	12	32	i. *t*.
	14	52	i. T.
	19	0	iv. *o*.
	23	40	iv. O.
23	1	47	iv. *e*.
	3	23	iii. *t*.
	6	22	iv. E.
	7	2	iii. T.
	9	39	i. *o*.
	12	40	i. E.
	21	58	ii. *o*.
24	2	17	ii. E.
	6	58	i. *t*.
	9	18	i. T.
25	4	5	i. *o*.
	7	8	i. E.
	16	5	ii. *t*.
	18	59	ii. T.
26	1	25	i. *t*.
	3	45	i. T.
	16	58	iii. *o*.
	22	32	i. *o*.
	23	42	iii. E.
27	1	37	i. E.
	11	7	ii. *o*.
	15	34	ii. E.
	19	51	i. *t*.
	22	11	i. T.
28	16	59	i. *o*.
	20	6	i. E.
29	5	15	ii. *t*.
	8	10	ii. T.
	14	18	i. *t*.
	16	38	i. T.

March.

d	h	m	
1	6	49	iii. *t*.
	10	27	iii. T.
	11	26	i. *o*.
	14	35	i. E.
2	0	17	ii. *o*.
	1	53	iv. *t*.
	4	52	ii. E.
	6	34	iv. T.
	8	45	i. *t*.
	11	5	i. T.

Mar. (co

d	h	m	
3	5	53	i.
	9	3	i.
	18	26	ii
	21	21	ii
4	3	12	i.
	5	32	i.
	20	26	ii
5	0	5	ii
	0	11	ii
	0	19	i.
	3	32	i.
	3	42	ii
	13	28	ii
	18	10	ii
	21	38	i.
	23	58	i.
6	18	46	i.
	22	1	i.
7	7	38	ii
	10	32	ii
	16	6	i.
	18	26	i.
8	10	19	ii
	13	14	i.
	13	58	ii
	16	30	i.
9	2	39	ii
	7	27	ii
	10	33	i.
	12	53	i.
10	7	41	i.
	10	16	i
	10	58	i.
	14	55	i
	19	50	i
	20	49	ii
	23	44	ii
11	0	28	i
	5	0	i.
	7	20	i.
	23	59	ii
12	2	8	i.
	3	38	ii
	4	10	ii
	5	26	i.
	7	42	ii
	15	50	ii
	20	45	ii
	23	27	i.
13	1	47	i.
	20	35	i.
	23	55	i.
14	10	2	ii
	12	57	ii

Mar. (con.).

l	h	m	
4	17	54	i. *t*.
	20	14	i. T.
5	13	55	iii. *t*.
	15	3	i. *o*.
	17	33	iii. T.
	18	25	i. E.
6	5	2	ii. *o*.
	10	3	ii. E.
	12	22	i. *t*.
	14	42	i. T.
7	9	31	i. *o*.
	12	54	i. E.
	23	15	ii. *t*.
8	2	10	ii. T.
	6	49	i. *t*.
	9	9	i. T.
	17	36	iv. *t*.
	22	15	iv. T.
9	3	37	iii. *o*.
	3	58	i. *o*.
	7	15	iii. O.
	7	22	i. E.
	8	10	iii. *e*.
	11	42	iii. E.
	18	15	ii. *o*.
	23	20	ii. E.
0	1	17	i. *t*.
	3	37	i. T.
	22	26	i. *o*.
1	1	51	i. E.
	12	30	ii. *t*.
	15	25	ii. T.
	19	44	i. *t*.
	22	4	i. T.
2	16	53	i. *o*.
	17	35	iii. *t*.
	20	20	i. E.
	21	13	iii. T.
3	7	28	ii. *o*.
	12	38	ii. E.
	14	12	i. *t*.
	16	32	i. T.
4	11	21	i. *o*.
	14	49	i. E.
5	1	44	ii. *t*.
	4	39	ii. T.
	8	40	i. *t*.
	11	0	i. T.
6	5	49	i. *o*.
	7	19	iii. *o*.
	9	18	i. E.
	10	57	iii. O.
	12	9	iii. *e*.
	15	41	iii. E.
	20	42	ii. *o*.
7	1	55	ii. E.
	2	30	iv. *o*.
	3	7	i. *t*.
	5	27	i. T.
	7	9	iv. O.
	13	54	iv. *e*.
	18	33	iv. E.
,	*0*	*17*	*i. o.*
	3	*47*	*i. E.*

Mar. (con.).

d	h	m	
28	15	0	ii. *t*.
	17	54	ii. T.
	21	35	i. *t*.
	23	55	i. T.
29	18	45	i. *o*.
	21	19	iii. *t*.
	22	15	i. E.
30	0	58	iii. T.
	9	57	ii. *o*.
	15	13	ii. E.
	16	3	i. *t*.
	18	23	i. T.
31	13	13	i. *o*.
	16	44	i. E.

April.

d	h	m	
1	4	15	ii. *t*.
	7	10	ii. T.
	10	31	i. *t*.
	12	51	i. T.
2	7	41	i. *o*.
	11	6	iii. *o*.
	11	13	i. E.
	14	44	iii. O.
	16	9	iii. *e*.
	19	41	iii. E.
	23	11	ii. *o*.
3	4	31	ii. E.
	4	59	i. *t*.
	7	19	i. T.
4	2	9	i. *o*.
	5	42	i. E.
	10	17	iv. *t*.
	14	56	iv. T.
	17	32	ii. *t*.
	20	26	ii. T.
	23	27	i. *t*.
5	1	47	i. T.
	20	38	i. *o*.
6	0	11	i. E.
	1	8	iii. *t*.
	4	46	iii. T.
	12	27	ii. *o*.
	17	48	ii. E.
	17	56	i. *t*.
	20	16	i. T.
7	15	6	i. *o*.
	18	40	i. E.
8	6	48	ii. *t*.
	9	43	ii. T.
	12	24	i. *t*.
	14	44	i. T.
9	9	35	i. *o*.
	13	9	i. E.
	14	58	iii. *o*.
	18	36	iii. O.
	20	9	iii. *e*.
	23	42	iii. E.
10	1	42	ii. *o*.
	6	52	i. *t*.
	7	6	ii. E.
	9	*12*	*i. T.*
11	*4*	*3*	*i. o.*

Apr. (con.).

d	h	m	
11	7	37	i. E.
	20	6	ii. *t*.
	23	1	ii. T.
12	1	21	i. *t*.
	3	41	i. T.
	19	43	iv. *o*.
	22	32	i. *o*.
13	0	22	iv. O.
	2	6	i. E.
	5	1	iii. *t*.
	7	57	iv. *e*.
	8	39	iii. T.
	12	39	iv. E.
	14	59	ii. *o*.
	19	49	i. *t*.
	20	23	ii. E.
	22	9	i. T.
14	17	0	i. *o*.
	20	35	i. E.
15	9	23	ii. *t*.
	12	18	ii. T.
	14	18	i. *t*.
	16	38	i. T.
16	11	29	i. *o*.
	15	4	i. E.
	18	54	iii. *o*.
	22	33	iii. O.
17	0	9	iii. *e*.
	3	42	iii. E.
	4	16	ii. *o*.
	8	46	i. *t*.
	9	40	ii. E.
	11	6	i. T.
18	5	58	i. O.
	9	33	i. E.
	22	43	ii. *t*.
19	1	37	ii. T.
	3	15	i. *t*.
	5	35	i. T.
20	0	27	i. *o*.
	4	2	i. E.
	8	59	iii. *t*.
	12	37	iii. T.
	17	33	ii. *o*.
	21	44	i. *t*.
	22	58	ii. E.
21	0	4	i. T.
	3	56	iv. *t*.
	8	35	iv. T.
	18	55	i. *o*.
	22	31	i. E.
22	12	1	ii. *t*.
	14	56	ii. T.
	16	12	i. *t*.
	18	32	i. T.
23	13	24	i. *o*.
	17	0	i. E.
	22	55	iii. *o*.
24	2	33	iii. O.
	4	10	iii. *e*.
	6	51	ii. *o*.
	7	43	iii. E.
	10	41	i. *t*.
	12	15	ii. E.

Apr. (con.).

d	h	m	
24	13	1	i. T.
25	7	53	i. *o*.
	11	28	i. E.
26	1	21	ii. *t*.
	4	16	ii. T.
	5	10	i. *t*.
	7	30	i. T.
27	2	22	i. *o*.
	5	57	i. E.
	13	0	iii. *t*.
	16	39	iii. T.
	20	9	ii. *o*.
	23	39	i. *t*.
28	1	33	ii. E.
	1	59	i. T.
	20	52	i. *o*.
29	0	26	i. E.
	13	50	iv. *o*.
	14	40	ii. *t*.
	17	35	ii. T.
	18	8	i. *t*.
	18	30	iv. O.
	20	28	i. T.
30	2	0	iv. *e*.
	6	44	iv. E.
	15	21	i. *o*.
	18	55	i. E.

May.

d	h	m	
1	2	59	iii. *o*.
	6	37	iii. O.
	8	9	iii. *e*.
	9	28	ii. *o*.
	11	43	iii. E.
	12	37	i. *t*.
	14	50	ii. E.
	14	57	i. T.
2	9	50	i. *o*.
	13	24	i. E.
3	4	1	ii. *t*.
	6	56	ii. T.
	7	6	i. *t*.
	9	26	i. T.
4	4	19	i. *o*.
	7	53	i. E.
	17	6	iii. *t*.
	20	45	iii. T.
	22	47	ii. *o*.
5	1	35	i. *t*.
	3	55	i. T.
	4	8	ii. E.
	22	49	i. *o*.
6	2	22	i. E.
	17	21	ii. *t*.
	20	4	i. *t*.
	20	16	ii. T.
	22	24	i. T.
7	17	18	i. *o*.
	20	50	i. E.
	22	24	iv. *t*.
8	3	4	iv. T.
	7	6	iii. *o*.
	10	45	iii. O.
	12	6	ii. *o*.

May (con.).

d	h	m	
8	12	9	iii. *e*.
	14	34	i. *t*.
	15	43	iii. E.
	16	54	i. T.
	17	25	ii. E.
9	11	47	i. *o*.
	15	19	i. E.
10	6	43	ii. *t*.
	9	3	i. *t*.
	9	38	ii. T.
	11	23	i. T.
11	6	17	i. *o*.
	9	48	i. E.
	21	14	iii. *t*.
12	0	53	iii. T.
	1	26	ii. *o*.
	3	32	i. *t*.
	5	52	i. T.
	6	42	ii. E.
13	0	47	i. *o*.
	4	17	i. E.
	20	4	ii. *t*.
	22	2	i. *t*.
	22	59	ii. T.
14	0	22	i. T.
	19	16	i. *o*.
	22	46	i. E.
15	11	16	iii. *o*.
	14	46	ii. *o*.
	14	55	iii. O.
	16	9	iii. *e*.
	16	31	i. *t*.
	18	51	i. T.
	19	42	iii. E.
	20	0	ii. E.
16	8	43	iv. *o*.
	13	25	iv. O.
	13	46	i. *o*.
	17	15	i. E.
	20	4	iv. *e*.
17	0	49	iv. E.
	9	26	ii. *t*.
	11	1	i. *t*.
	12	21	ii. T.
	13	21	i. T.
18	8	15	i. *o*.
	11	44	i. E.
19	1	26	iii *t*.
	4	7	ii. *o*.
	5	6	iii. T.
	5	30	i. *t*.
	7	50	i. T.
	9	17	ii. E.
20	2	45	i. *o*.
	6	12	i. E.
	22	48	ii. *t*.
21	0	0	i. *t*.
	1	43	ii. T.
	2	20	i. T.
	21	15	i. *o*.
22	0	41	i. E.
	15	30	iii. *o*.
	17	27	ii. *o*.
	18	29	i. *t*.

May (con.).

d	h	m	
22	19	9	iii. (
	20	8	iii. *e*
	20	49	i. T.
	22	34	ii .E
	23	42	iii. I
23	15	44	i. *o*.
	19	10	i. E.
24	12	11	ii. *t*.
	12	59	i. *t*.
	15	6	ii. T
	15	19	i. T.
	17	32	iv. *t*
	22	16	iv. T
25	10	14	i. *o*.
	13	39	i. E.
26	5	40	iii. *t*
	6	48	ii. *o*.
	7	28	i. *t*.
	9	20	iii. T
	9	48	i. T.
	11	51	ii. E
27	4	44	i. *o*.
	8	8	i. E.
28	1	33	ii. *t*.
	1	58	i. *t*.
	4	18	i. T.
	4	28	ii. T.
	23	14	i. *o*.
29	2	37	i. E.
	19	46	iii. *o*
	20	10	ii. *o*.
	20	28	i. *t*.
	22	48	i. T.
	23	26	iii. C
30	0	8	iii. *e*
	1	9	ii. E
	3	42	iii. I
	17	44	i. *o*.
	21	5	i. E.
31	14	57	ii. *t*.
	14	58	i. *t*.
	17	18	i. T.
	17	52	ii. T

June.

d	h	m	
1	12	14	i. *o*.
	15	34	i. E.
2	4	13	iv. *o*
	8	58	iv. (
	9	27	i. *t*.
	9	31	ii. *o*.
	9	57	iii. *t*
	11	48	i. T.
	13	37	iii. T
	14	7	iv. *e*
	14	26	ii. E
	18	53	iv. I
3	6	44	i. *o*.
	10	3	i. E.
4	3	57	i. *t*.
	4	21	ii. *t*.
	6	17	i. T.
	7	15	ii. T
5	1	14	i. *o*.

June (con.).

d	h	m	
5	4	32	i. E.
	22	27	i. *t*.
	22	53	ii. *o*.
6	0	5	iii. *o*.
	0	47	i. T.
	3	43	ii. E.
	3	45	iii. O.
	4	8	iii. *e*.
	7	42	iii. E.
	19	44	i. *o*.
	23	1	i. E.
7	16	57	i. *t*.
	17	42	ii. *t*.
	19	17	i. T.
	20	38	ii. T.
8	14	14	i. *o*.
	17	30	i. E.
9	11	27	i. *t*.
	12	15	ii. *o*.
	13	47	i. T.
	14	15	iii. *t*.
	17	1	ii. E.
	17	56	iii. T.
10	8	44	i. *o*.
	11	58	i. E.
	13	14	iv. *t*.
	18	1	iv. T.
11	5	56	i. *t*.
	7	6	ii. *t*.
	8	17	i. T.
	10	2	ii. T.
12	3	14	i. *o*.
	6	27	i. E.
13	0	26	i. *t*.
	1	38	ii. *o*.
	2	47	i. T.
	4	25	iii. *o*.
	6	18	ii. E.
	8	6	iii. O.
	8	8	iii. *e*.
	11	42	iii. E.
	21	44	i. *o*.
14	0	56	i. E.
	18	56	i. *t*.
	20	31	ii. *t*.
	21	17	i. T.
	23	26	ii. T.
15	16	14	i. *o*.
	19	25	i. E.
16	13	27	i. *t*.
	15	0	ii. *o*.
	15	47	i. T.
	18	35	iii. *t*.
	19	35	ii. E.
	22	16	iii. T.
17	10	44	i. *o*.
	13	53	i. E.
18	7	56	i. *t*.
	9	54	ii. *t*.
	10	17	i. T.
	12	50	ii. T.
19	0	11	iv. *o*.
	4	59	iv. O.
	5	14	i. *e*.

June (con.).

d	h	m	
19	8	9	iv. *e*.
	8	22	i. E.
	12	56	iv. E.
20	2	26	i. *t*.
	4	23	ii. *o*.
	4	47	i. T.
	8	47	iii. *o*.
	8	52	ii. E.
	15	42	iii. E.
	23	44	i. *o*.
21	2	51	i. E.
	20	56	i. *t*.
	23	17	i. T.
	23	19	ii. *t*.
22	2	15	ii. T.
	18	15	i. *o*.
	21	20	i. E.
23	15	27	i. *t*.
	17	46	ii. *o*.
	17	47	i. T.
	22	10	ii. E.
	22	58	iii. *t*.
24	2	40	iii. T.
	12	45	i. *o*.
	15	48	i. E.
25	9	57	i. *t*.
	12	17	i. T.
	12	43	ii. *t*.
	15	39	ii. T.
26	7	15	i. *o*.
	10	17	i. E.
27	4	27	i. *t*.
	6	47	i. T.
	7	9	ii. *o*.
	9	20	iv. *t*.
	11	27	ii. E.
	13	10	iii. *o*.
	14	10	iv. T.
	19	41	iii. E.
28	1	45	i. *o*.
	4	46	i. E.
	22	57	i. *t*.
29	1	17	i. T.
	2	8	ii. *t*.
	5	4	ii. T.
	20	16	i. *o*.
	23	15	i. E.
30	17	27	i. *t*.
	19	47	i. T.
	20	32	ii. *o*.

July.

d	h	m	
1	0	44	ii. E.
	3	22	iii. *t*.
	7	4	iii. T.
	14	46	i. *o*.
	17	43	i. E.
2	11	57	i. *t*.
	14	17	i. T.
	15	32	ii. *t*.
	18	28	ii. T.
3	9	16	i. *o*.
	12	12	i. E.

July (con.).

d	h	m	
4	6	28	i. *t*.
	8	48	i. T.
	9	55	ii. *o*.
	14	2	ii. E.
	17	34	iii. *o*.
	23	40	iii. E.
5	3	47	i. *o*.
	6	41	i. E.
	20	29	iv. *o*.
6	0	58	i. *t*.
	1	20	iv. O.
	2	12	iv. *e*.
	3	18	i. T.
	4	57	ii. *t*.
	6	59	iv. E.
	7	53	ii. T.
	22	17	i. *o*.
7	1	10	i. E.
	19	28	i. *t*.
	21	48	i. T.
	23	19	ii. *o*.
8	3	19	ii. E.
	7	47	iii. *t*.
	11	29	iii. T.
	16	47	i. *o*.
	19	38	i. E.
9	13	58	i. *t*.
	16	18	i. T.
	18	21	ii. *t*.
	21	17	ii. T.
10	11	18	i. *o*.
	14	7	i. E.
11	8	28	i. *t*.
	10	49	i. T.
	12	43	ii. *o*.
	16	37	ii. E.
	22	0	iii. *o*.
12	3	39	iii. E.
	5	48	i. *o*.
	8	36	i. E.
13	2	58	i. *t*.
	5	19	i. T.
	7	46	ii. *t*.
	10	42	ii. T.

September.

d	h	m	
10	3	32	ii. O.
	10	31	i. *e*.
	13	18	i. O.
	23	47	iii. *t*.
11	2	16	iv. *e*.
	3	29	iii. T.
	8	7	i. *t*.
	10	27	i. T.
	11	51	iv. O.
	19	48	ii. *t*.
	22	44	ii. T.
12	5	0	i. *e*.
	7	48	i. O.
13	2	37	i. *t*.
	4	57	i. T.
	12	58	ii. *e*.
	16	56	ii. O.

Sept. (con.).

d	h	m	
13	23	28	i. *e*.
14	2	18	i. O.
	11	55	iii. *e*.
	17	45	iii. O.
	21	7	i. *t*.
	23	27	i. T.
15	9	12	ii. *t*.
	12	8	ii. T.
	17	57	i. *e*.
	20	48	i. O.
16	15	37	i. *t*.
	17	57	i. T.
17	2	16	ii. *e*.
	6	20	ii. O.
	12	25	i. *e*.
	15	18	i. O.
18	4	12	iii. *t*.
	7	54	iii. T.
	10	7	i. *t*.
	12	27	i. T.
	22	36	ii. *t*.
19	1	32	ii. T.
	6	53	i. *e*.
	9	48	i. O.
	15	58	iv. *t*.
	20	52	iv. T.
20	4	37	i. *t*.
	6	57	i. T.
	15	33	ii. *e*.
	19	44	ii. O.
21	1	22	i. *e*.
	4	18	i. O.
	15	53	iii. *e*.
	22	9	iii. O.
	23	7	i. *t*.
22	1	27	i. T.
	12	0	ii. *t*.
	14	56	ii. T.
	19	50	i. *e*.
	22	48	i. O.
23	17	37	i. *t*.
	19	57	i. T.
24	4	51	ii. *e*.
	9	8	ii. O.
	14	19	i. *e*.
	17	18	i. O.
25	8	36	iii. *t*.
	12	7	i. *t*.
	12	17	iii. T.
	14	27	i. T.
26	1	23	ii. *t*.
	4	19	ii. T.
	8	47	i. *e*.
	11	48	i. O.
27	6	37	i. *t*.
	8	57	i. T.
	18	9	ii. *e*.
	20	16	iv. *e*.
	22	32	ii. O.
28	1	0	iv. E.
	3	15	i. *e*.
	3	19	iv. *o*.
	6	18	i. O.
	8	11	iv. O.

Sept. (con.).

d	h	m	
28	19	51	iii. *e*.
29	1	7	i. *t*.
	2	32	iii. O.
	3	27	i. T.
	14	47	ii. *t*.
	17	42	ii. T.
	21	44	i. *e*.
30	0	48	i. O.
	19	37	i. *t*.
	21	57	i. T.

October.

d	h	m	
1	7	26	ii. *e*.
	11	55	ii. O.
	16	12	i. *e*.
	19	17	i. O.
2	12	58	iii. *t*.
	14	6	i. *t*.
	16	26	i. T.
	16	39	iii. T.
3	4	10	ii. *t*.
	7	5	ii. T.
	10	41	i. *e*.
	13	47	i. O.
4	8	36	i. *t*.
	10	56	i. T.
	20	44	ii. *e*.
5	1	19	ii. O.
	5	9	i. *e*.
	8	17	i. O.
	23	49	iii. *e*.
6	3	6	i. *t*.
	5	26	i. T.
	6	52	iii. O.
	12	9	iv. *t*.
	17	0	iv. T.
	17	33	ii. *t*.
	20	28	ii. T.
	23	37	i. *e*.
7	2	47	i. O.
	21	36	i. *t*.
	23	56	i. T.
8	10	1	ii. *e*.
	14	42	ii. O.
	18	6	i. *e*.
	21	16	i. O.
9	16	5	i. *t*.
	17	19	iii. *t*.
	18	25	i. T.
	20	59	iii. T.
10	6	55	ii. *t*.
	9	50	ii. T.
	12	34	i. *e*.
	15	46	i. O.
11	10	35	i. *t*.
	12	54	i. T.
	23	19	ii. *e*.
12	4	5	ii. O.
	7	2	i. *e*.
	10	15	i. O.
13	3	47	iii. *e*.
	5	5	i. *t*.
	7	19	iii. E.

Oct. (con.

d	h	m	
13	7	25	i.
	7	31	iii.
	11	11	iii.
	20	17	ii.
	23	12	ii.
14	1	31	i.
	4	45	i.
	14	16	iv.
	18	59	iv.
	23	23	iv.
	23	35	i.
15	1	54	i.
	4	11	iv.
	12	36	ii.
	17	27	ii.
	19	59	i.
	23	15	i.
16	18	4	i.
	20	24	i.
	21	38	iii.
17	1	17	iii.
	9	39	ii.
	12	34	ii.
	14	27	i.
	17	44	i.
18	12	34	i.
	14	53	i.
19	1	55	ii.
	6	50	ii.
	8	56	i.
	12	14	i.
20	7	3	i.
	7	44	iii.
	9	23	i.
	11	16	iii.
	11	48	iii.
	15	27	iii.
	23	1	ii.
21	1	55	ii.
	3	24	i.
	6	43	i.
22	1	33	i.
	3	52	i.
	15	12	ii.
	20	12	ii.
	21	52	i.
23	1	12	i.
	7	57	iv.
	12	43	iv.
	20	2	i.
	22	21	i.
24	1	54	iii.
	5	32	iii.
	12	22	ii.
	15	16	ii.
	16	21	i.
	19	42	i.
25	14	32	i.
	16	51	i.
26	4	30	ii.
	9	34	ii.
	10	49	i.
	14	11	i.
27	9	1	i.

Oct. (con.).

d	h	m	
27	11	21	i. T.
	11	43	iii. *e.*
	15	14	iii. E.
	16	4	iii. *o.*
	19	42	iii. O.
28	1	43	ii. *t.*
	4	37	ii. T.
	5	17	i. *e.*
	8	40	i. O.
29	3	30	i. *t.*
	5	50	i. T.
	17	47	ii. *e.*
	22	56	ii. O.
	23	45	i. *e.*
30	3	9	i. O.
	21	59	i. *t.*
31	0	19	i. T.
	6	7	iii. *t.*
	8	15	iv. *e.*
	9	45	iii. T.
	12	56	iv. E.
	15	4	ii. *t.*
	17	58	ii. T.
	18	14	i. *e.*
	18	58	iv. *o.*
	21	38	i. O.
	23	41	iv. O.

November.

d	h	m	
1	16	29	i. *t.*
	18	48	i. T.
2	7	6	ii. *e.*
	12	17	ii. O.
	12	42	i. *e.*
	16	7	i. O.
3	10	58	i. *t.*
	13	18	i. T.
	15	40	iii. *e.*
	19	12	iii. E.
	20	16	iii. *o.*
	23	53	iii. O.
4	4	24	ii. *t.*
	7	10	i. *e.*
	7	17	ii. T.
	10	37	i. O.
5	5	28	i. *t.*
	7	47	i. T.
	20	23	ii. *e.*
6	1	38	ii. O.
	1	38	i. *e.*
	5	6	i. O.

Nov. (con.).

d	h	m	
6	23	56	i. *t.*
7	2	16	i. T.
	10	18	iii. *t.*
	13	55	iii. T.
	17	44	ii. *t.*
	20	7	i. *e.*
	20	37	ii. T.
	23	35	i. O.
8	18	25	i. *t.*
	20	45	i. T.
9	3	13	iv. *t.*
	7	52	iv. T.
	9	41	ii. *e.*
	14	35	i. *e.*
	14	58	ii. O.
	18	3	i. O.
10	12	54	i. *t.*
	15	14	i. T.
	19	38	iii. *e.*
	23	10	iii. E.
11	0	26	iii. *o.*
	4	2	iii. O.
	7	3	ii. *t.*
	9	3	i. *e.*
	9	56	ii. T.
	12	32	i. O.
12	7	23	i. *t.*
	9	43	i. T.
	22	59	ii. *e.*
13	3	31	i. *e.*
	4	19	ii. O.
	7	1	i. O.
14	1	52	i. *t.*
	4	12	i. T.
	14	26	iii. *t.*
	18	1	iii. T.
	20	22	ii. *t.*
	22	0	i. *e.*
	23	15	ii. T.
15	1	30	i. O.
	20	21	i. *t.*
	22	41	i. T.
16	12	17	ii. *e.*
	16	28	i. *e.*
	17	38	ii. O.
	19	58	i. O.
17	2	13	iv. *e.*
	6	53	iv. E.
	13	57	iv. *o.*
	14	50	i. *t.*
	17	9	i. T.
	18	33	iv. O.

Nov. (con.).

d	h	m	
17	23	36	iii. *e.*
18	3	7	iii. E.
	4	32	iii. *o.*
	8	7	iii. O.
	9	40	ii. *t.*
	10	56	i. *e.*
	12	33	ii. T.
	14	27	i. O.
19	9	19	i. *t.*
	11	38	i. T.
20	1	34	ii. *e.*
	5	24	i. *e.*
	6	58	ii. O.
	8	56	i. O.
21	3	48	i. *t.*
	6	7	i. T.
	18	31	iii. *t.*
	22	5	iii. T.
	22	58	ii. *t.*
	23	53	i. *e.*
22	1	51	ii. T.
	3	24	i. O.
	22	16	i. *t.*
23	0	36	i. T.
	14	53	ii. *e.*
	18	21	i. *e.*
	20	17	ii. O.
	21	53	i. O.
24	16	45	i. *t.*
	19	4	i. T.
25	3	33	iii. *e.*
	7	3	iii. E.
	8	33	iii. *o.*
	12	7	iii. O.
	12	16	ii. *t.*
	12	49	i. *e.*
	15	8	ii. T.
	16	21	i. O.
	21	46	iv. *t.*
26	2	19	iv. T.
	11	13	i. *t.*
	13	33	i. T.
27	4	10	ii. *e.*
	7	17	i. *e.*
	9	35	ii. O.
	10	49	i. O.
28	5	42	i. *t.*
	8	1	i. T.
	22	31	iii. *t.*
29	1	33	ii. *t.*
	1	46	i. *e.*
	2	5	iii. T.

Nov. (con.).

d	h	m	
29	4	25	ii. T.
	5	17	i. O.
30	0	10	i. *t.*
	2	29	i. T.
	17	29	ii. *e.*
	20	14	i. *e.*
	22	53	ii. O.
	23	46	i. O.

December.

d	h	m	
1	18	38	i. *t.*
	20	58	i. T.
2	7	30	iii. *e.*
	11	0	iii. E.
	12	31	iii. *o.*
	14	42	i. *e.*
	14	49	ii. *t.*
	16	4	iii. O.
	17	41	ii. T.
	18	14	i. O.
3	13	6	i. *t.*
	15	26	i. T.
	20	12	iv. *e.*
4	0	50	iv. E.
	6	46	ii. *e.*
	8	10	iv. *o.*
	9	10	i. *e.*
	12	11	ii. O.
	12	38	iv. O.
	12	42	i. O.
5	7	35	i. *t.*
	9	54	i. T.
6	2	28	iii. *t.*
	3	38	i. *e.*
	4	5	ii. *t.*
	6	1	iii. T.
	6	57	ii. T.
	7	10	i. O.
7	2	3	i. *t.*
	4	22	i. T.
	20	5	ii. *e.*
	22	7	i. *e.*
8	1	28	ii. O.
	1	38	i. O.
	20	31	i. *t.*
	22	50	i. T.
9	11	28	iii. *e.*
	14	57	iii. E.
	16	26	iii. *o.*
	16	35	i. *e.*

Dec. (con.).

d	h	m	
9	17	21	ii. *t.*
	19	57	iii. O.
	20	6	i. O.
	20	12	ii. T.
10	14	59	i. *t.*
	17	18	i. T.
11	9	22	ii. *e.*
	11	3	i. *e.*
	14	33	i. O.
	14	44	ii. O.
12	9	27	i. *t.*
	11	46	i. T.
	15	29	iv. *t.*
	19	54	iv. T.
13	5	31	i. *e.*
	6	20	iii. *t.*
	6	36	ii. *t.*
	9	1	i. O.
	9	27	ii. T.
	9	52	iii. T.
14	3	55	i. *t.*
	6	14	i. T.
	22	41	ii. *e.*
	23	59	i. *e.*
15	3	29	i. O.
	4	0	ii. O.
	22	23	i. *t.*
16	0	42	i. T.
	15	26	iii. *e.*
	18	28	i. *e.*
	18	55	iii. E.
	19	50	ii. *t.*
	20	15	iii. *o.*
	21	56	i. O.
	22	41	ii. T.
	23	46	iii. O.
17	16	50	i. *t.*
	19	10	i. T.
18	11	58	ii. *e.*
	12	56	i. *e.*
	16	24	i. O.
	17	15	ii. O.
19	11	18	i. *t.*
	13	37	i. T.
20	7	24	i. *e.*
	9	3	ii. *t.*
	10	7	iii. *t.*
	10	52	i. O.
	11	54	ii. T.
	13	38	iii. T.
	14	11	iv. *e.*
	18	46	iv. E.

Dec.

d	h	
21	1	2
	5	4
	5	4
	8	
22	1	1
	1	5
	5	1
	6	3
23	0	1
	2	3
	19	2
	20	2
	22	1
	22	5
	23	4
24	0	
	1	
	3	3
	18	4
	21	
25	14	3
	14	4
	18	1
	19	4
26	13	
	15	2
27	9	1
	11	2
	12	4
	13	4
	14	1
	17	1
28	7	3
	9	5
29	3	4
	3	5
	7	
	8	1
	8	5
	12	3
30	2	
	4	2
	22	1
	23	2
31	0	4
	1	3
	2	5
	3	3
	3	4
	7	1
	20	3
	22	4

The satellites of Jupiter will be invisible from July 14 until September 10, Jupiter being too near
Satellites I. & II. *disappear* at eclipse on the *p* side in January. They *reappear* on the *f* si
February to July, and *disappear* on the *p* side from September to December.

Satellites III. & IV. *disappear* at eclipse on the *p* side in January. They *reappear* on the
February, and both *disappear* and *reappear* on the *f* side from March to July. They *disap*
reappear on the *p* side from September to December.

CONFIGURATIONS OF JUPITER'S SATELLITES

FOR AN INVERTING TELESCOPE.

Day.	Jan. 13h	Feb. 12h	March. 11h	April. 10h 30m	May. 10h	June. 9h 30m	July. 9h	Sept. 16h 30m	Oct. 16h	Nov. 15h 30m	Dec. 15h	Day.
1	42O13	421O3	231O4	321O4	O14●●	241O3	413O2		1O234	32O14	43O12	1
2	41O23	432O1	♃34O2	23O4●	O234●	♃2O34	43O12		♃♃O24	3O24●	♃4O●●	2
3	♃4O13	431O2	34O12	1O234	21O34	3O24●	4321O		32O14	13O24	♃24O3	3
4	213O4	♃43O1	4231O	♃O123	2O134	312O4	4321O		321O4	2O134	O4213	4
5	3O214	241O3	42O13	421O3	31O24	32O14	4O132		3O124	12O34	1O324	5
6	31O24	O123●	41O23	432O1	3O124	1O324	12O43		♃1O23	O1234	23O14	6
7	23O14	O243●	42O13	431O2	321O4	O1234	2O134		42O13	13O24	321O4	7
8	2O134	21O34	♃421O	432O1	42O1●	21O34	♃1O24		41O23	32O14	3O124	8
9	1O234	32O14	♃34O2	423O●	41O23	2O134	3O124		4O132	34O2●	13O24	9
10	O2134	31O24	3O12●	41O23	♃42O3	3O42●	321O4	4O132	432O1	431O2	♃2O34	10
11	213O4	♃3O14	321O4	4O123	42O13	♃341O	♃32O4	31O24	4321O	42O13	O2143	11
12	34O21	21O4●	2O314	214O3	431O2	432O1	O1324	32O14	43O12	421O3	1O432	12
13	341O2	O2143	1O234	23O1●	43O12	41O2●	♃1O43	31O4●	41O32	4O123	432O1	13
14	423O1	♃1O23	♃O134	31O24	4321O	4O123		O124●	2O13●	♃41O2	4321O	14
15	42O3●	♃42O3	21O34	♃3O14	423O1	421O3		21O34	1O43●	432O1	43O12	15
16	41O23	423O1	3O124	231O4	1O23●	42O13		♃2O34	O1324	341O●	413O2	16
17	4O213	431O2	3O24●	♃O234	♃O143	431O2		O1324	32O4●	♃3O2●	42O13	17
18	♃421O	43O21	321O4	O1234	2O34●	♃34O2		31O24	321O4	2O134	4O3●●	18
19	34O1●	4213O	42O1●	21O34	31O24	32O1●		♃32O1	3O124	21O34	41O23	19
20	314O2	4O13●	41O23	♃2O14	3O124	1O24●		341O●	1O324	O1234	23O1●	20
21	32O14	41O23	4O213	314O2	321O4	O1234		4O12●	2O134	1O324	321O4	21
22	21O34	24O13	421O3	34O21	23O14	21O34		412O3	1O43●	32O14	3O124	22
23	♃O234	23O4●	43O1●	4231O	1O234	2O134		42O13	4O132	31O4●	31O24	23
24	O1234	31O24	431O2	4O13●	O2143	31O24		4O23●	4312O	3O124	2O134	24
25	21O34	3O124	4321O	4O23●	241O3	3O124		431O2	♃432O	2O34●	O34●●	25
26	3O14●	213O4	42O31	421O3	431O●	32O4●		342O1	43O12	241O3	♃O234	26
27	31O24	O134●	1O423	42O31	43O12	♃13O●		3142O	413O2	4O123	♃2O14	27
28	32O41	1O234	O2143	431O2	4312O	4O123		3O412	42O13	41O32	321O4	28
29	241O3	2O134	21O34	34O21	423O1	412O3		♃1O34	412O3	432O1	34O21	29
30	♃4O23		3O14●	321O4	41O32	42O13		2O134	4O132	4312O	431O2	30
31	4O123		31O24		4O213				♃314O		42O13	31

The circle (O) represents Jupiter; ♃ signifies that the satellite is on the disk; ● signifies that the satellite is behind the disk or in the shadow.

TABLE OF BESSEL'S MEAN REFRACTIONS.

Z. D.	Mean Refraction.	Z. D.	Mean Refraction.	Z. D.	Mean Refraction.	Z. D.	Mean Refraction.
°	′ ″	°	′ ″	°	′ ″	°	′ ″
0	0·0	56	1 25·4	68	2 21·9	78	4 25·0
10	10·2	58	1 32·1	69	2 29·3	79	4 48·5
20	21·0	60	1 39·7	70	2 37·3	80	5 16·2
30	33·3	61	1 43·8	71	2 46·1	81	5 49·3
35	40·4	62	1 48·2	72	2 55·8	82	6 29·6
40	48·4	63	1 52·8	73	3 6·6	83	7 19·7
45	57·7	64	1 57·8	74	3 18·6	84	8 23·3
50	1 8·7	65	2 3·2	75	3 32·1	85	9 46·5
52	1 13·8	66	2 8·9	76	3 47·4		
54	1 19·3	67	2 15·2	77	4 4·9		

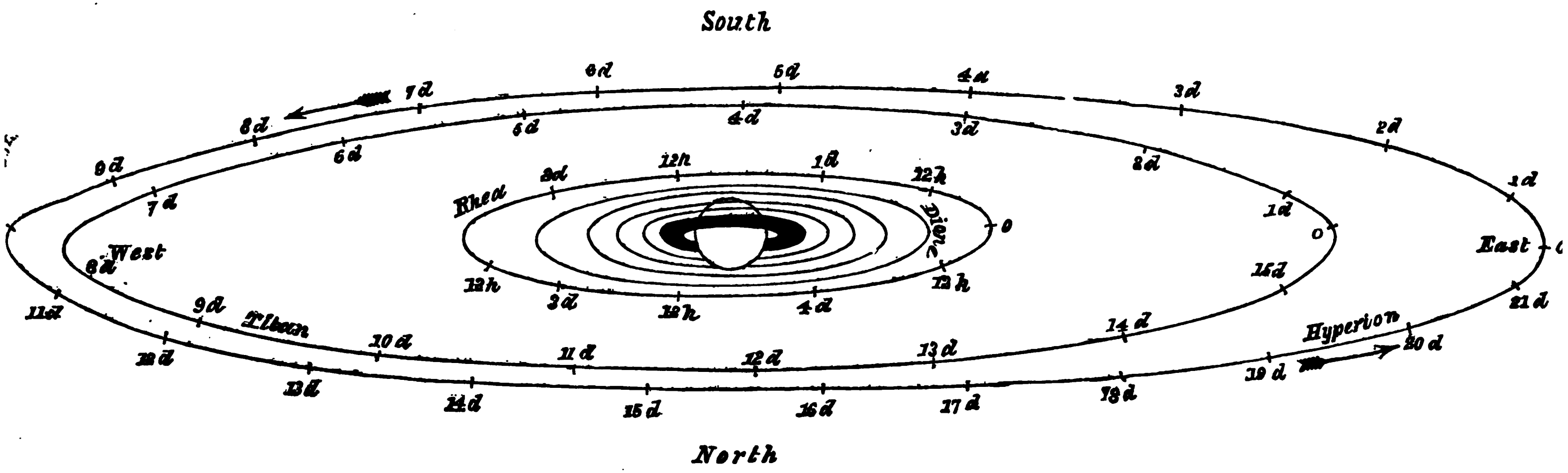
EPHEMERIS OF JUPITER'S VTH SATELLITE.

Noon.		P+90°.	*a*.	*b*.	*l*−L.	Time of greatest Elongation W.	
		°	″	″	°	h	m
Jan.	1	106·57	57·11	+0·44	19·55	20	16
	3	106·49	57·28	0·44	25·09	20	5
	5	106·42	57·44	0·44	30·64	19	54
	7	106·34	57·58	0·45	36·18	19	43
	9	106·25	57·71	0·45	41·73	19	32
	11	106·16	57·82	0·45	47·28	19	21
	13	106·08	57·92	0·46	52·83	19	10
	15	105·99	58·00	0·46	58·38	18	59
	17	105·89	58·06	0·46	63·93	18	48
	19	105·80	58·11	0·47	69·47	18	37
	21	105·71	58·13	0·47	75·01	18	26
	23	105·61	58·15	0·48	80·55	18	15
	25	105·51	58·14	0·48	86·08	18	4
	27	105·42	58·12	0·49	91·61	17	53
	29	105·32	58·08	0·49	97·13	17	42
	31	105·23	58·02	0·49	102·64	17	31
Feb.	2	105·13	57·95	0·50	108·15	17	20
	4	105·04	57·86	0·50	113·64	17	9
	6	104·94	57·75	0·51	119·13	16	58
	8	104·85	57·63	0·51	124·60	16	47
	10	104·76	57·49	0·51	130·07	16	36
	12	104·67	57·34	0·52	135·52	16	25
	14	104·59	57·17	0·52	140·97	16	14
	16	104·51	56·99	0·53	146·40	16	4
	18	104·43	56·80	0·53	151·81	15	53
	20	104·35	56·59	0·53	157·21	15	42
	22	104·28	56·37	0·53	162·60	15	31
	24	104·21	56·14	0·54	167·98	15	21
	26	104·14	55·90	0·54	173·34	15	10
	28	104·08	55·65	0·54	178·69	14	59
Mar.	1	104·02	55·40	0·54	184·02	14	49
	3	103·97	55·13	0·54	189·33	14	38
	5	103·92	54·85	0·54	194·63	14	28
	7	103·87	54·57	0·54	199·92	14	17
	9	103·83	54·28	0·54	205·19	14	7
	11	103·79	53·99	0·54	210·44	13	56
	13	103·76	53·69	0·54	215·68	13	46
	15	103·74	53·39	0·54	220·90	13	35
	17	103·72	53·08	0·54	226·11	13	25
	19	103·70	52·77	0·54	231·30	13	15
	21	103·69	52·46	0·54	236·48	13	4
	23	103·68	52·14	0·54	241·64	12	54
	25	103·68	51·83	0·53	246·79	12	44
	27	103·68	51·51	0·53	251·92	12	33
	29	103·69	51·20	0·53	257·04	12	23
	31	103·71	50·88	0·52	262·15	12	13
Apr.	2	103·73	50·56	0·52	267·24	12	3
	4	103·75	50·25	0·52	272·31	11	53
	6	103·78	49·93	0·51	277·38	11	43
	8	103·81	49·62	0·51	282·43	11	33
	10	103·85	49·31	0·50	287·47	11	23
	12	103·89	49·01	0·50	292·49	11	13
	14	103·93	48·70	0·49	297·50	11	3
	16	103·98	48·40	0·49	302·50	10	53
	18	104·04	48·10	0·48	307·50	10	43
	20	104·10	47·80	0·48	312·49	10	33
	22	104·16	47·51	0·47	317·44	10	23
	24	104·22	47·23	0·46	322·40	10	13
	26	104·29	46·95	0·46	327·35	10	3
	28	104·37	46·67	0·45	332·29	9	53
	30	104·44	46·39	+0·44	337·22	9	44

The differences between successive values of *l*−L for the interval of two days vary between 1444°·93 and 1445°·55. To find rectangular coordinates at any time the value of *l*−L must be interpolated when the coordinates are given by

$x = a \sin (l - L)$ in pos. angle P+90°.
$y = b \cos (l - L)$ „ „ P.

APPARENT ORBITS OF THE SEVEN INNER SATELLITES OF SATURN, as seen in an Inverting Telescope.



The arrows in the diagram show the direction of the motion of the Satellites. The figures indicate the interval from the time of last East Elongation.

SATELLITES OF SATURN.

East Elongations.

MIMAS.

January.		February.		March.		April.		May.		June.		July.		August.	
d	h	d	h	d	h	d	h	d	h	d	h	d	h	d	h
1	23·1	1	2·9	1	8·3	1	10·4	1	14·0	1	16·4	1	19·5	1	0·0
2	21·7	2	1·6	2	6·9	2	9·0	2	12·6	2	15·0	2	18·1	1	22·6
3	20·3	3	0·2	3	5·5	3	7·7	3	11·3	3	13·7	3	16·7	2	21·2
4	19·0	3	22·9	4	4·1	4	6·3	4	9·9	4	12·3	4	15·3	3	19·8
5	17·6	4	21·5	5	2·7	5	4·9	5	8·5	5	10·9	5	13·9	4	18·4
6	16·2	5	20·1	6	1·3	6	3·5	6	7·2	6	9·5	6	12·5	5	17·0
7	14·8	6	18·8	6	23·9	7	2·2	7	5·8	7	8·1	7	11·0	6	15·6
8	13·4	7	17·4	7	22·5	8	0·8	8	4·4	8	6·7	8	10·6	7	14·2
9	12·1	8	16·0	8	21·1	8	23·4	9	3·0	9	5·3	9	9·2	8	12·8
10	10·7	9	14·6	9	19·7	9	22·0	10	1·6	10	3·9	10	7·9	9	11·4
11	9·3	10	13·3	10	18·3	10	20·6	11	0·2	11	2·5	11	6·5	10	10·0
12	7·9	11	11·9	11	17·0	11	19·2	11	22·9	12	1·1	12	5·1		
13	6·6	12	10·5	12	15·6	12	17·8	12	21·5	12	23·7	13	3·7		
14	5·2	13	9·1	13	14·2	13	16·4	13	20·1	13	22·3	14	2·3		
15	3·8	14	7·7	14	12·8	14	15·1	14	18·7	14	21·0	15	0·9		
16	2·5	15	6·4	15	11·4	15	13·7	15	17·3	15	19·6	15	23·5		
17	1·1	16	5·0	16	10·0	16	12·3	16	15·9	16	18·2	16	22·1		
17	23·7	17	3·6	17	8·6	17	10·9	17	14·6	17	16·8	17	20·7		
18	22·3	18	2·2	18	7·2	18	9·5	18	13·2	18	15·4	18	19·3		
19	20·9	19	0·8	19	5·8	19	8·1	19	11·8	19	14·1	19	17·9		
20	19·5	19	23·4	20	4·4	20	6·8	20	10·5	20	12·7	20	16·5		
21	18·1	20	22·0	21	3·0	21	5·4	21	9·1	21	11·3	21	15·1		
22	16·7	21	20·7	22	1·6	22	4·0	22	7·7	22	9·9	22	13·7		
23	15·3	22	19·3	23	0·2	23	2·6	23	6·3	23	8·5	23	12·3		
24	13·9	23	17·9	23	22·8	24	1·2	24	4·9	24	7·1	24	11·0		
25	12·5	24	16·5	24	21·5	24	23·9	25	3·5	25	5·6	25	9·6		
26	11·1	25	15·2	25	20·1	25	22·5	26	2·2	26	4·1	26	8·2		
27	9·8	26	13·8	26	18·8	26	21·1	27	0·8	27	2·7	27	6·9		
28	8·4	27	12·4	27	17·4	27	19·7	27	23·4	28	1·3	28	5·5		
29	7·0	28	11·0	28	16·0	28	18·3	28	22·0	28	23·8	29	4·1		
30	5·7	29	9·7	29	14·6	29	16·9	29	20·6	29	22·3	30	2·8		
31	4·3			30	13·2	30	15·5	30	19·2	30	20·9	31	1·4		
				31	11·8			31	17·8						

ENCELADUS.

January.		February.		March.		April.		May.		June.		July.	
d	h	d	h	d	h	d	h	d	h	d	h	d	h
2	6·0	1	9·7	1	4·3	1	16·5	1	19·8	2	7·9	1	2·4
3	14·9	2	18·6	2	13·2	3	1·4	3	4·7	3	16·8	2	11·3
4	23·8	4	3·5	3	22·0	4	10·3	4	13·5	5	1·7	3	20·2
6	8·7	5	12·4	5	6·9	5	19·1	5	22·4	6	10·6	5	5·0
7	17·6	6	21·3	6	15·8	7	4·0	7	7·3	7	19·5	6	13·9
9	2·5	8	6·1	8	0·7	8	12·8	8	16·2	9	4·4	7	22·8
10	11·4	9	15·0	9	9·6	9	21·7	10	1·1	10	13·3	9	7·7
11	20·3	10	23·9	10	18·5	11	6·6	11	10·0	11	22·1	10	16·6
13	5·2	12	8·8	12	3·4	12	15·5	12	18·8	13	7·0	12	1·5
14	14·1	13	17·7	13	12·3	14	0·4	14	3·7	14	15·9	13	10·4
15	23·0	15	2·6	14	21·2	15	9·3	15	12·5	16	0·8	14	19·3
17	7·8	16	11·5	16	6·1	16	18·2	16	21·4	17	9·6	16	4·2
18	16·7	17	20·3	17	14·9	18	3·1	18	6·3	18	18·5	17	13·0
20	1·7	19	5·2	18	23·8	19	11·9	19	15·2	20	3·4	18	21·9
21	10·6	20	14·1	20	8·7	20	20·8	21	0·0	21	12·3	20	6·8
22	19·5	21	23·0	21	17·5	22	5·7	22	8·9	22	21·1	21	15·7
24	4·4	23	7·9	23	2·4	23	14·6	23	17·7	24	6·0	23	0·6
25	13·3	24	16·8	24	11·3	24	23·5	25	2·6	25	14·9	24	9·5
26	22·1	26	1·7	25	20·2	26	8·4	26	11·5	26	23·7	25	18·4
28	7·0	27	10·6	27	5·0	27	17·2	27	20·4	28	8·6	27	3·3
29	*15·9*	28	19·5	28	13·9	29	2·1	29	5·2	29	17·5	28	12·2
31	*0·8*			29	22·8	30	11·0	30	14·1				
				31	7·6			31	23·0				

East Elongations.

TETHYS.

January.	February.	March.	April.	May.	June.	July.	August.
d h	d h	d h	d h	d h	d h	d h	d h
1 13·0	2 15·3	1 23·1	1 3·8	1 8·4	2 10·5	2 15·2	1 20·0
3 10·3	4 12·6	3 20·4	3 1·1	3 5·7	4 7·8	4 12·5	3 17·3
5 7·6	6 9·9	5 17·6	4 22·4	5 3·0	6 5·1	6 9·8	5 14·6
7 4·9	8 7·2	7 14·9	6 19·7	7 0·3	8 2·3	8 7·1	7 11·9
9 2·2	10 4·5	9 12·2	8 17·0	8 21·6	9 23·6	10 4·4	
10 23·5	12 1·8	11 9·5	10 14·2	10 18·9	11 20·8	12 1·8	
12 20·8	13 23·1	13 6·8	12 11·5	12 16·2	13 18·1	13 23·1	
14 18·1	15 20·5	15 4·1	14 8·8	14 13·5	15 15·4	15 20·4	
16 15·4	17 17·8	17 1·5	16 6·1	16 10·8	17 12·8	17 17·7	
18 12·7	19 15·1	18 22·8	18 3·3	18 8·1	19 10·1	19 14·9	
20 10·0	21 12·5	20 20·1	20 0·6	20 5·4	21 7·4	21 12·2	
22 7·4	23 9·8	22 17·4	21 21·9	22 2·7	23 4·7	23 9·5	
24 4·7	25 7·1	24 14·7	23 19·2	24 0·0	25 2·0	25 6·8	
26 2·0	27 4·4	26 12·0	25 16·5	25 21·3	26 23·3	27 4·1	
27 23·3	29 1·8	28 9·2	27 13·8	27 18·6	28 20·6	29 1·4	
29 20·6		30 6·5	29 11·1	29 15·9	30 17·9	30 22·7	
31 17·9				31 13·2			

DIONE.

January.	February.	March.	April.	May.	June.	July.
d h	d h	d h	d h	d h	d h	d h
3 5·0	2 7·8	3 10·5	2 12·9	2 14·8	1 17·1	1 19·4
5 22·7	5 1·5	6 4·1	5 6·5	5 8·5	4 10·7	4 13·1
8 16·4	7 19·2	8 21·8	8 0·2	8 2·1	7 4·3	7 6·8
11 10·1	10 12·9	11 15·5	10 17·8	10 19·8	9 22·0	10 0·5
14 3·8	13 6·6	14 9·2	13 11·4	13 13·5	12 15·6	12 18·2
16 21·5	16 0·3	17 2·9	16 5·0	16 7·1	15 9·3	15 11·9
19 15·2	18 18·0	19 20·6	18 22·6	19 0·8	18 3·0	18 5·6
22 8·9	21 11·7	22 14·2	21 16·2	21 18·5	20 20·7	20 23·2
25 2·6	24 5·4	25 7·9	24 9·8	24 12·1	23 14·3	
27 20·3	26 23·1	28 1·5	27 3·5	27 5·8	26 8·0	
30 14·0	29 16·8	30 19·2	29 21·2	29 23·4	29 1·7	

RHEA.

January.	February.	March.	April.	May.	June.	July.
d h	d h	d h	d h	d h	d h	d h
4 13·7	5 5·2	3 7·7	3 22·2	1 0·3	1 14·5	3 5·0
9 2·1	9 17·7	7 20·1	8 10·6	5 12·6	6 2·8	7 17·3
13 14·6	14 6·1	12 8·5	12 23·0	10 0·9	10 15·2	12 5·7
18 3·1	18 18·5	16 20·8	17 11·3	14 13·2	15 3·5	16 18·1
22 15·7	23 6·9	21 9·1	21 23·6	19 1·5	19 15·9	21 6·5
27 4·2	27 19·3	25 21·5	26 12·0	23 13·8	24 4·2	
31 16·7		30 9·9		28 2·1	28 16·6	

TITAN.

January.	February.	March.	April.	May.	June.
d h	d h	d h	d h	d h	d h
11 20·5	12 19·7	15 17·2	16 12·6	2 10·0	3 4·7
27 20·3	28 18·6	31 15·4		18 7·4	19 1·5

East Elongations.

HYPERION.

January.	February.	March.	April.	May.	June.	July.
d h	d h	d h	d h	d h	d h	d h
1 5·9	12 15·1	4 19·6	16 4·8	7 9·6	18 20·0	10 1·6
22 10·5		26 0·4		28 14·6		31 7·1

IAPETUS.

	d h	d h	d h
Inf. Conjunction ...	Jan. 26 6·3,	Apr. 13 15·9,	July 1 3·5.
W. Elongation	Feb. 15 12·4,	May 3 22·0,	July 21 9·5.
Sup. Conjunction ...	Mar. 6 15·8,	May 24 1·8,	Aug. 10 13·5.
E. Elongation	Jan. 8 8·1,	Mar. 26 17·3,	June 13 4·7.

Apparent Elements of Saturn's Rings.

Greenwich Mean Noon.	Position-angle of Minor Axis.	Outer Ring.		Latitude above Plane of Ring.	
		Maj. Axis.	Min. Axis.	Earth.	Sun.
	° ′	″	″	° ′	° ′
Jan. 1	1 0·9	36·04	13·24	21 33·6 N.	20 8·5 N.
21	1 12·5	37·09	13·83	21 53·2 N.	20 19·6 N.
Feb. 10	1 19·6	38·34	14·39	22 2·7 N.	20 31·1 N.
Mar. 1	1 21·4	39·65	14·87	22 1·8 N.	20 42·3 N.
21	1 18·0	40·86	15·21	21 51·3 N.	20 53·4 N.
April 10	1 10·0	41·76	15·34	21 33·0 N.	21 4·4 N.
30	0 59·1	42·19	15·24	21 10·0 N.	21 15·3 N.
May 20	0 47·6	42·06	14·92	20 46·8 N.	21 25·9 N.
June 9	0 37·7	41·41	14·48	20 28·2 N.	21 36·4 N.
29	0 31·3	40·35	14·01	20 18·5 N.	21 46·7 N.
July 19	0 29·5	39·09	13·58	20 19·8 N.	21 56·9 N.
Aug. 8	0 32·7	37·79	13·26	20 32·6 N.	22 7·0 N.
28	0 40·6	36·60	13·07	20 55·4 N.	22 16·8 N.
Sept. 17	0 52·7	35·61	13·01	21 25·6 N.	22 26·4 N.
Oct. 7	1 8·0	34·89	13·07	22 0·3 N.	22 36·1 N.
27	1 25·6	34·46	13·24	22 36·2 N.	22 45·4 N.
Nov. 16	1 44·5	34·34	13·52	23 10·6 N.	22 54·6 N.
Dec. 6	2 3·2	34·55	13·88	23 41·1 N.	23 3·7 N.
26	2 20·5	35·08	14·32	24 5·8 N.	23 12·7 N.
31	2 24·5	35·26	14·45	24 11·0 N.	23 14·9 N.

SATELLITES OF URANUS.

North Elongations.

Ariel.

February.		March.		April.		May.		June.		July.		August.	
d	h	d	h	d	h	d	h	d	h	d	h	d	h
4	21·3	1	2·2	2	20·6	3	2·5	2	8·5	2	14·5	1	20·5
7	9·8	3	14·7	5	9·1	5	15·0	4	21·0	5	3·0	4	9·0
9	22·3	6	3·2	7	21·6	8	3·5	7	9·5	7	15·5	6	21·5
12	10·7	8	15·7	10	10·1	10	16·0	9	22·0	10	4·0		
14	23·2	11	4·2	12	22·6	13	4·5	12	10·5	12	16·5		
17	11·7	13	16·7	15	11·1	15	17·0	14	23·0	15	5·0		
20	0·2	16	5·2	17	23·6	18	5·5	17	11·5	17	17·5		
22	12·7	18	17·7	20	12·1	20	18·0	20	0·0	20	6·0		
25	1·2	21	6·1	23	0·6	23	6·5	22	12·5	22	18·5		
27	13·7	23	18·6	25	13·1	25	19·0	25	1·0	25	7·0		
		26	7·1	28	1·6	28	7·5	27	13·5	27	19·5		
		28	19·6	30	14·1	30	20·0	30	2·0	30	8·0		
		31	8·1										

Umbriel.

February.		March.		April.		May.		June.		July.		August.		September.	
d	h	d	h	d	h	d	h	d	h	d	h	d	h	d	h
4	21·1	4	21·4	2	21·7	1	22·0	4	1·8	3	2·2	1	2·5	......	
9	0·6	9	0·9	7	1·2	6	1·5	8	5·3	7	5·7	5	6·0	......	
13	4·1	13	4·4	11	4·7	10	5·0	12	8·8	11	9·1	9	9·5	......	
17	7·6	17	7·8	15	8·2	14	8·5	16	12·3	15	12·6	13	13·0	......	
21	11·0	21	11·3	19	11·6	18	12·0	20	15·8	19	16·1	17	16·5	......	
25	14·5	25	14·8	23	15·1	22	15·4	24	19·2	23	19·6	21	19·9	......	
29	17·9	29	18·3	27	18·6	26	18·9	28	22·7	27	23·0				
						30	22·4								

Titania.

10	0·0	7	3·1	2	6·1	7	2·2	2	5·3	7	1·4	2	4·5	6	0·6
18	17·0	15	20·1	10	23·2	15	19·2	10	22·3	15	18·5	10	21·5		
27	10·1	24	13·1	19	16·2	24	12·3	19	15·4	24	11·5	19	14·6		
				28	9·2			28	8·4			28	7·6		

Oberon.

18	20·9	3	8·2	12	18·1	9	16·7	5	15·3	2	14·0	......		......	
		16	19·5	26	5·4	23	4·0	19	2·7	16	1·3	......		......	
		30	6·8												

Position-angle and distance of the apse of Oberon:—February 12, 354°·4, 43″·1; May 14, 356·5, 45″·5; August 10, 358°·2, 43″·2.

SATELLITE OF NEPTUNE.

North-east Elongations.

January.		February.		March.		August.		September.		October.		November.		December.	
d	h	d	h	d	h	d	h	d	h	d	h	d	h	d	h
3	16·7	2	2·2	2	11·7	31	13·7	6	10·8	5	20·3	4	5·7	3	15·1
9	13·8	7	23·3	8	8·8			12	7·9	11	17·3	9	2·8	9	12·2
15	10·9	13	20·4	14	5·9			18	5·0	17	14·4	15	23·8	15	9·3
21	8·0	19	17·5	20	3·0			24	2·1	23	11·5	21	20·9	21	6·4
27	5·1	25	14·6					29	23·2	29	8·6	27	18·0	27	3·4

Position-angle and distance of the apse:—March 11, 250°·4, 16″·3; September 15, 255°·7, 16″·4; December 12, 254°·3, 16″·9.

EPHEMERIS FOR PHYSICAL OBSERVATIONS OF THE SUN.

Greenwich Mean Noon.				Greenwich Mean Noon.			
1896.	P.	D.	L.	1896.	P.	D.	L.
	° ′	° ′	° ′		° ′	° ′	° ′
Jan. 1	+ 1 55	−3 15	237 27	July 4	− 0 48	+3 30	315 36
6	− 0 33	3 49	171 36	9	+ 1 28	4 1	249 26
11	2 57	4 20	105 44	14	3 43	4 30	183 17
16	5 20	4 50	39 54	19	5 56	4 58	117 8
21	7 38	5 18	334 4	24	8 6	5 23	50 59
26	9 52	5 43	268 14	29	10 10	5 46	344 50
31	12 0	6 5	202 24	Aug. 3	12 10	6 7	278 43
Feb. 5	14 1	6 25	136 34	8	14 4	6 25	212 36
10	15 54	6 41	70 44	13	15 51	6 41	146 30
15	17 39	6 54	4 54	18	17 32	6 53	80 25
20	19 16	7 4	299 3	23	19 4	7 3	14 20
25	20 43	7 11	233 12	28	20 30	7 10	308 17
Mar. 1	22 2	7 15	167 20	Sept. 2	21 47	7 14	242 15
6	23 10	7 15	101 28	7	22 56	7 15	176 13
11	24 10	7 11	35 35	12	23 56	7 12	110 11
16	24 59	7 5	329 41	17	24 47	7 7	44 11
21	25 37	6 55	263 46	22	25 28	6 58	338 10
26	26 6	6 42	197 48	27	25 59	6 46	272 13
31	26 23	6 26	131 51	Oct. 2	26 19	6 32	206 15
Apr. 5	26 30	6 7	65 52	7	26 29	6 13	140 17
10	26 26	5 46	359 52	12	26 28	5 53	74 19
15	26 10	5 23	293 51	17	26 16	5 30	8 22
20	25 44	4 56	227 48	22	25 52	5 5	302 25
25	25 6	4 29	161 44	27	25 16	4 36	236 29
30	24 18	3 59	95 40	Nov. 1	24 29	4 5	170 33
May 5	23 18	3 27	29 35	6	23 29	3 33	104 38
10	22 8	2 54	323 27	11	22 18	2 59	38 43
15	20 48	2 20	257 18	16	20 56	2 24	332 48
20	19 18	1 45	191 10	21	19 22	1 47	266 53
25	17 39	1 10	125 2	26	17 38	1 9	200 58
30	15 52	−0 34	58 53	Dec. 1	15 44	+0 31	135 5
June 4	13 57	+0 2	352 42	6	13 41	−0 1	69 12
9	11 55	0 38	286 31	11	11 31	0 45	3 20
14	9 48	1 14	220 20	16	9 14	1 23	297 28
19	7 36	1 49	154 9	21	6 52	2 1	231 36
24	5 21	2 24	87 58	26	4 28	2 37	165 44
29	− 3 6	+2 57	21 47	31	+ 2 1	−3 13	99 52

The position-angle of the Sun's axis, P, is the position-angle of the N. end of the axis from the N. point of the Sun, read in the direction N., E., S., W. In computing D (the heliographic latitude of the centre of the Sun's disk), the inclination of the Sun's axis to the ecliptic has been assumed to be 82° 45′, and the longitude of the ascending node to be 74° 22′. In computing L (the heliographic longitude of the centre of the disk), the Sun's period of rotation has been assumed to be 25·38 days, and the meridian which passed through the ascending node at the epoch 1854·0 has been taken as the zero meridian.

MEAN PLACES OF VARIABLE STARS FOR 1896·0.

No.	Star.	R.A.	Dec.	No.	Star.	R.A.	Dec.
		h m s	° ′			h m s	° ′
1.	S Sculptoris	0 10 7	−32 37·4	58.	R Cancri	8 10 50	+12 2·7
2.	T Andromedæ	0 16 58	+26 25·1	59.	V Cancri	8 15 47	+17 36·9
3.	T Cassiopeiæ	0 17 36	+55 13·0	60.	V Carini	8 26 36	−59 46·3
4.	R Andromedæ	0 18 32	+38 0·1	61.	U Cancri	8 29 49	+19 15·3
5.	S Ceti	0 18 46	− 9 54·3	62.	T Velorum	8 34 18	−46 59·8
6.	U Cassiopeiæ	0 40 33	+47 41·3	63.	S Cancri	8 38 0	+19 24·5
7.	U Cephei	0 53 4	+81 18·9	64.	S Hydræ	8 48 9	+ 3 27·7
8.	S Cassiopeiæ	1 12 0	+72 3·8	65.	T Hydræ	8 50 36	− 8 44·7
9.	S Piscium	1 12 8	+ 8 23·0	66.	T Cancri	8 50 44	+20 14·9
10.	U Piscium	1 17 28	+12 19·3	67.	W Carini	9 19 7	−55 30·9
11.	R Sculptoris	1 22 11	−33 4·9	68.	S Antliæ	9 27 45	−28 10·2
12.	R Piscium	1 25 16	+ 2 20·7	69.	N Velorum	9 28 4	−56 34·5
13.	S Arietis	1 59 3	+12 1·7	70.	S Velorum	9 29 18	−44 44·9
14.	R Arietis	2 10 12	+24 34·4	71.	R Carini	9 29 38	−62 19·7
15.	*o* Ceti	2 14 5	− 3 26·9	72.	R Leo. Min.	9 39 21	+34 59·5
16.	R Ceti	2 20 43	− 0 38·9	73.	R Leonis	9 41 58	+11 54·7
17.	U Ceti	2 28 44	−13 36·3	74.	*l* Carini	9 42 23	−62 1·7
18.	R Trianguli	2 30 44	+33 48·7	75.	V Leonis	9 54 17	+21 45·5
19.	T Arietis	2 42 31	+17 4·5	76.	S Carini	10 6 3	−61 2·5
20.	Algol	3 1 24	+40 33·3	77.	R Ursæ Maj.	10 37 17	+69 19·3
21.	U Arietis	3 5 17	+14 24·4	78.	V Hydræ	10 47 34	−20 41·9
22.	R Persei	3 23 25	+35 19·1	79.	W Leonis	10 48 9	+14 16·2
23.	λ Tauri	3 54 55	+12 11·8	80.	U Carini	10 53 34	−59 10·6
24.	W Tauri	4 22 6	+15 52·2	81.	S Leonis	11 5 28	+ 6 1·5
25.	R Tauri	4 22 36	+ 9 55·8	82.	R Comæ	11 58 55	+19 21·8
26.	S Tauri	4 23 30	+ 9 42·9	83.	S Muscæ	12 7 11	−69 34·4
27.	T Camelopardi	4 30 3	+65 58·4	84.	T Virginis	12 9 17	− 5 27·5
28.	R Reticuli	4 32 28	−63 14·7	85.	R Corvi	12 14 15	−18 40·6
29.	V Tauri	4 46 1	+17 21·8	86.	R Crucis	12 17 55	−61 3·1
30.	R Orionis	4 53 22	+ 7 58·4	87.	Y Virginis	12 28 31	− 3 50·9
31.	R Leporis	4 54 52	−14 57·8	88.	T Ursæ Maj.	12 31 39	+60 3·6
32.	V Orionis	5 0 35	+ 3 57·6	89.	R Virginis	12 33 13	+ 7 33·6
33.	R Aurigæ	5 8 54	+53 28·2	90.	R Muscæ	12 35 44	−68 50·2
34.	S Orionis	5 23 52	− 4 46·5	91.	S Ursæ Maj.	12 39 24	+61 39·8
35.	S Camelopardi	5 29 47	+68 44·4	92.	U Virginis	12 45 49	+ 6 7·2
36.	U Aurigæ	5 35 17	+31 58·5	93.	S Crucis	12 48 13	−57 52·0
37.	U Orionis	5 49 39	+20 9·4	94.	W Virginis	13 20 40	− 2 50·3
38.	η Geminorum	6 8 36	+22 32·2	95.	V Virginis	13 22 26	− 2 38·0
39.	V Aurigæ	6 16 0	+47 42·8	96.	R Hydræ	13 24 2	−22 44·6
40.	V Monocerotis	6 17 29	− 2 8·6	97.	S Virginis	13 27 34	− 6 39·6
41.	T Monocerotis	6 19 36	+ 7 8·6	98.	W Hydræ	13 43 10	−27 50·8
42.	S Monocerotis	6 35 15	+ 9 59·3	99.	R Canum Ven.	13 44 29	+40 3·6
43.	R Lyncis	6 52 43	+55 28·6	100.	R^2 Virginis	13 59 22	− 8 42·0
44.	ζ Geminorum	6 57 57	+20 43·3	101.	Z Virginis	14 4 45	−12 48·7
45.	R Geminorum	7 1 6	+22 51·9	102.	R Centauri	14 9 5	−59 25·7
46.	R Canis Min.	7 2 59	+10 11·2	103.	Y Boötis	14 17 11	+20 16·9
47.	L^2 Puppis	7 10 22	−44 28·4	104.	X Boötis	14 19 16	+16 47·5
48.	R Canis Maj.	7 14 46	−16 12·0	105.	S Boötis	14 19 24	+54 17·0
49.	V Geminorum	7 17 19	+13 17·5	106.	S^2 Virginis	14 22 4	+ 5 8·7
50.	U Monocerotis	7 25 50	− 9 33·5	107.	R Camelopardi	14 25 26	+84 18·2
51.	S Canis Min.	7 27 5	+ 8 32·4	108.	V Boötis	14 25 34	+39 19·5
52.	T Canis Min.	7 28 13	+11 58·0	109.	R Boötis	14 32 36	+27 11·3
53.	U Canis Min.	7 35 42	+ 8 37·4	110.	V Libræ	14 34 34	−17 12·5
54.	S Geminorum	7 36 48	+23 41·7	111.	U Boötis	14 49 31	+18 7·1
55.	T Geminorum	7 43 4	+23 59·6	112.	δ Libræ	14 55 25	− 8 6·3
56.	U Geminorum	7 48 56	+22 16·5	113.	T Triang. Austr.	15 0 3	−68 19·2
57.	U Puppis	7 55 57	−12 33·2	114.	T Libræ	15 4 48	−19 37·3

Mean Places of Variable Stars for 1896·0 (continued).

No.	Star.	R.A.			Dec.		No.	Star.	R.A.			Dec.	
		h	m	s	°	′			h	m	s	°	′
115.	Y Libræ	15	6	11	− 5	37·1	170.	S Sagittarii......	19	13	21	−19	12·8
116.	R Triang. Austr.	15	10	28	−66	6·8	171.	Z Sagittarii......	19	13	33	−21	7·0
117.	U Coronæ	15	13	57	+32	1·7	172.	T Sagittæ	19	17	4	+17	27·4
118.	S Libræ	15	15	24	−20	0·7	173.	U Aquilæ	19	23	45	− 7	15·5
119.	S Serpentis......	15	16	47	+14	41·2	174.	R Cygni	19	34	2	+49	58·0
120.	S Coronæ	15	17	10	+31	44·5	175.	T^2 Cygni.........	19	40	43	+48	31·3
121.	S^2 Libræ.........	15	18	15	−22	32·4	176.	S Vulpeculæ ...	19	44	8	+27	1·7
122.	X Libræ	15	30	12	−20	49·1	177.	X Aquilæ.........	19	46	19	+ 4	11·9
123.	W Libræ.........	15	31	58	−15	49·8	178.	χ Cygni	19	46	34	+32	39·1
124.	U Libræ	15	35	59	−20	50·7	179.	η Aquilæ.........	19	47	11	+ 0	44·3
125.	Z Libræ	15	40	27	−20	47·8	180.	R^2 Sagittarii ...	19	49	28	−29	27·6
126.	V Coronæ	15	45	49	+39	53·0	181.	S Sagittæ	19	51	17	+16	21·4
127.	R Serpentis......	15	45	54	+15	27·0	182.	Z Cygni	19	58	31	+49	45·2
128.	R Libræ	15	47	43	−15	55·6	183.	S Cygni	20	3	19	+57	41·2
129.	R^2 Libræ.........	15	50	25	−17	59·9	184.	R Capricorni ...	20	5	28	−14	34·7
130.	S Triang. Austr.	15	51	51	−63	28·8	185.	S Aquilæ.........	20	6	50	+15	18·7
131.	X Herculis	15	59	32	+47	31·4	186.	W Capricorni...	20	8	22	−22	17·7
132.	Z Scorpii.........	15	59	54	−21	27·0	187.	R Sagittæ	20	9	19	+16	24·6
133.	R Herculis	16	1	33	+18	39·1	188.	R Delphini......	20	9	54	+ 8	46·4
134.	X Scorpii	16	2	26	−21	14·8	189.	U Cygni	20	16	23	+47	34·0
135.	W Scorpii	16	5	41	−19	52·0	190.	V Cygni	20	37	57	+47	46·2
136.	R Scorpii	16	11	27	−22	41·3	191.	S Delphini	20	38	17	+16	42·9
137.	S Scorpii.........	16	11	28	−22	38·2	192	X Cygni	20	39	20	+35	12·7
138.	W Ophiuchi ...	16	15	49	− 7	27·0	193.	T Delphini	20	40	32	+16	1·2
139.	V Ophiuchi ...	16	20	56	−12	11·5	194.	W Aquarii	20	40	58	− 4	27·8
140.	U Herculis	16	21	13	+19	7·5	195.	V Aquarii	20	41	34	+ 2	3·4
141.	Y Scorpii	16	23	35	−19	12·7	196.	U Capricorni ...	20	42	21	−15	10·0
142.	T Ophiuchi......	16	27	47	−15	54·6	197.	R^2 Cygni.........	20	42	29	+44	29·3
143.	S Ophiuchi......	16	28	16	−16	56·5	198.	V Delphini......	20	43	3	+18	57·2
144.	R Aræ............	16	31	6	−56	47·1	199.	T Aquarii	20	44	27	− 5	31·9
145.	W Herculis......	16	31	32	+37	33·1	200.	T Vulpeculæ ...	20	47	4	+27	51·4
146.	Y Herculis	16	31	49	+ 7	19·1	201.	Y Cygni	20	47	55	+34	16·0
147.	R Draconis ...	16	32	23	+66	58·3	202.	R Vulpeculæ ...	20	59	46	+23	24·6
148.	S Herculis	16	47	9	+15	7·0	203.	V Capricorni ...	21	1	34	−24	20·6
149.	R^2 Scorpii	16	50	0	−30	24·8	204.	X Capricorni ...	22	2	36	−21	46·0
150.	R Ophiuchi......	17	1	48	−15	57·2	205.	T Cephei.........	21	8	10	+68	4·1
151.	U Ophiuchi......	17	11	15	+ 1	19·6	206.	T Capricorni ...	21	16	17	−15	35·9
152.	Z Ophiuchi......	17	14	16	+ 1	37·6	207.	Y Capricorni ...	21	28	42	−14	26·1
153.	X Sagittarii ...	17	41	1	−27	47·4	208.	W Cygni.........	21	32	7	+44	54·6
154.	Y Ophiuchi......	17	47	4	− 6	7·1	209.	S Cephei	21	36	31	+78	9·4
155.	Z Herculis	17	53	25	+15	8·4	210.	U^2 Cygni.........	21	37	8	+53	51·2
156.	W Sagittarii ...	17	58	23	−29	35·2	211.	U Aquarii	21	57	41	−17	7·7
157.	T Herculis	18	5	10	+31	0·1	212.	S Piscis Aust. ...	21	57	49	−28	33·2
158.	Y Sagittarii......	18	15	16	−18	54·4	213.	T Pegasi	22	3	49	+12	1·9
159.	T Serpentis......	18	23	44	+ 6	13·7	214.	S Lacertæ	22	24	27	+39	47·0
160.	U Sagittarii ...	18	25	46	−19	12·0	215.	δ Cephei	22	25	18	+57	53·0
161.	X Ophiuchi ...	18	33	24	+ 8	44·2	216.	W Cephei	22	32	30	+57	53·4
162.	R Scuti	18	41	56	− 5	49·0	217.	R Lacertæ	22	38	40	+41	49·6
163.	κ Pavonis	18	46	14	−67	21·8	218.	S Aquarii	22	51	32	−20	53·9
164.	β Lyræ	18	46	14	+33	14·5	219.	R Pegasi	23	1	26	+ 9	58·9
165.	R Lyræ	18	52	10	+43	48·5	220.	S Pegasi	23	15	17	+ 8	21·0
166.	R Coron. Austr.	18	54	53	−37	6·0	221.	R Aquarii	23	38	26	−15	51·6
167.	R Aquilæ	19	1	22	+ 8	4·4	222.	V Cephei.........	23	51	33	+82	36·7
168.	T Sagittarii ...	19	10	14	−17	9·2	223.	V Ceti............	23	52	35	− 9	32·4
169.	R Sagittarii ...	19	10	36	−19	29·4	224.	R Cassiopeiæ ...	23	53	7	+50	48·6

VARIABLES OF SHORT PERIOD NOT OF THE ALGOL TYPE.

(The No. after Star's Name refers to Catalogue on pp. 25–26.)

.—The times of minima only are given; the times of maxima may be found by adding the interval printed under the name of the star.

NOCER. 41.

$7^{d}\ 22\tfrac{1}{2}^{h}$.)

	d	h
May	23	11
June	19	11
July	16	11
Aug.	12	11
Sept.	8	11
Oct.	5	11
Nov.	1	11
	28	11
Dec.	25	11

MINOR. 44.

($5^{d}\ 0^{h}$.)

	d	h
May	1	18
	11	21
	22	1
June	2	5
	12	9
Aug.	2	3
	12	7
	22	10
Sept.	1	14
	11	18
Sept.	21	21
Oct.	2	1
	12	5
	22	9
Nov.	1	12
	11	16
	21	20
Dec.	1	23
	12	3
	22	7
	32	10

RGINIS 94.

$8^{d}\ 5^{h}$.)

	d	h
Feb.	8	3
	25	10
Mar.	13	16
	30	23

W Virginis 94

(*continued*).

	d	h
Apr.	17	5
May	4	12
	21	18
June	8	1
	25	7
July	12	14
	29	20
Aug.	16	3
Oct.	6	22
	24	5
Nov.	10	11
	27	18
Dec.	15	0

X Sagittar. 153.

($2^{d}\ 21^{h}$.)

	d	h
Jan.	27	15
Feb.	3	15
	10	16
	17	16
	24	16
Mar.	2	16
	9	17
	16	17
	23	17
	30	18
Apr.	6	18
	13	18
	20	18
	27	19
May	4	19
	11	19
	18	20
	25	20
June	1	20
	8	20
	15	21
	22	21
	29	21
July	6	22
	13	22
	20	22
	27	22
Aug.	3	23
	10	23
	17	23
	24	23
Sept.	1	0
	8	0
	15	0
	22	1
	29	1
Oct.	6	1
	13	1
	20	2
	27	2
Nov.	3	2
	10	3
	17	3
	24	3
Dec.	1	4
	8	5

Y Ophiuchi 154.

($6^{d}\ 6^{h}$.)

	d	h
Jan.	9	0
	26	3
Feb.	12	6
	29	9
Mar.	17	12
Apr.	3	15
	20	18
May	7	21
	25	0
June	11	3
	28	6
July	15	9
Aug.	1	12
	18	15
Sept.	4	18
	21	21
Oct.	9	0
	26	3

W Sagittar. 156.

($3^{d}\ 0^{h}$.)

	d	h
Jan.	26	5
Feb.	2	20
	10	10
	18	0
	25	14
Mar.	4	5
	11	19
	19	9
	26	23
Apr.	3	14
	11	4
	18	18
	26	9
May	3	23
	11	13
	19	3
	26	18
June	3	8
	10	22
	18	12
	26	3
July	3	17
	11	7
	18	22
	26	12
Aug.	3	2
	10	16
	18	7
Aug.	25	21
Sept.	2	11
	10	1
	17	16
	25	6
Oct.	2	20
	10	10
	18	1
	25	15
Nov.	2	5
	9	20
	17	10
	25	0
Dec.	3	14

Y Sagittar. 158.

($1^{d}\ 19^{h}$.)

	d	h
Jan.	26	4
	31	23
Feb.	6	18
	12	12
	18	7
	24	1
	29	20
Mar.	6	14
	12	9
	18	4
	23	22
	29	17
Apr.	4	11
	10	6
	16	0
	21	19
	27	13
May	3	8
May	9	3
	14	21
	20	16
	26	10
June	1	5
	6	23
	12	18
	18	12
	24	7
	30	2
July	5	20
	11	15
	17	10
	23	4
	28	22
Aug.	3	17
	9	11
	15	6
	21	1
Aug.	26	19
Sept.	1	14
	7	8
	13	3
	18	21
	24	16
	30	10
Oct.	6	5
	12	0
	17	18
	23	13
	29	7
Nov.	4	2
	9	20
	15	15
	21	9
	27	4
Dec.	2	23

U Sagittar. 160.

($2^{d}\ 23^{h}$.)

	d	h
Jan.	24	7
	31	1
Feb.	6	9
	13	13
	20	7
	27	1
Mar.	4	19
	11	12
	18	6
	25	0
	31	18
Apr.	7	12
	14	6
Apr.	21	0
	27	18
May	4	11
	11	5
	17	23
	24	17
	31	11

U Sagittar. 160

(*continued*).

	d	h
June	7	5
	13	23
	20	17
	27	10
July	4	4
	10	22
	17	16
	24	10
	31	4
Aug.	6	22
	13	15
	20	9
	27	3
Sept.	2	21
	9	15
	16	9
	23	3
	29	21
Oct.	6	14
	13	8
	20	2
	26	20
Nov.	2	14
	9	8
	16	2

β Lyræ 164.

(Max. $3^{d}\ 5^{h}$.

Secondary Min.

$6^{d}\ 11^{h}$.

Max. $9^{d}\ 16^{h}$.)

	d	h
Jan.	9	18
	22	16
Feb.	4	14
	17	12
Mar.	1	10
	14	8
	27	6
Apr.	9	4
	22	2
May	5	0
	17	22
	30	20
June	12	18
	25	16
July	8	14
	21	12
Aug.	3	10
	16	8
	29	6
Sept.	11	4
	24	2
Oct.	7	0
	19	22
Nov.	1	20
	14	17
	27	15
Dec.	10	13
	23	11

Variables of Short Period (*continued*).

U Aquilæ 173.

(2ᵈ 3ʰ.)

Feb.	May	Sept.
d h	d h	d h
6 3	21 12	3 21
13 4	28 13	10 22
20 4	June	17 23
27 5	4 13	24 23
Mar.	11 14	Oct.
5 6	18 15	2 0
12 6	25 15	9 0
19 7	July	16 1
26 7	2 16	23 2
Apr.	9 16	30 2
2 8	16 17	Nov.
9 9	23 18	6 3
16 9	30 18	13 3
23 10	Aug.	20 4
30 10	6 19	27 5
May	13 20	Dec.
7 11	20 20	4 5
14 12	27 21	

η Aquilæ 179.

(2ᵈ 9ʰ.)

Feb.	Apr.	June
d h	d h	d h
7 20	5 6	1 16
15 0	12 10	8 20
22 4	19 14	16 0
29 9	26 18	23 4
		30 8
Mar.	May	July
7 13	3 23	7 13
14 17	11 3	14 17
21 21	18 7	21 21
29 1	25 11	29 1

η Aquilæ 179 (*continued*).

Aug.	Oct.	Nov.
d h	d h	d h
5 6	1 16	20 21
12 10	8 20	28 1
19 14	16 0	
26 18	23 4	
Sept.	30 8	Dec.
2 23	Nov.	5 6
10 3	6 13	12 10
17 7	13 17	19 14
24 11		26 18

S Sagittæ 181.

(3ᵈ 10ʰ.)

Jan.	May	Sept.
d h	d h	d h
23 10	11 9	5 18
31 19	19 19	14 3
Feb.	28 4	22 13
9 4	June	30 22
17 13	5 13	Oct.
25 23	13 22	9 7
Mar.	22 7	17 16
5 8	30 17	26 1
13 17	July	Nov.
22 2	9 2	3 11
30 11	17 11	11 20
Apr.	25 20	20 5
7 21	Aug.	28 14
16 6	3 5	Dec.
24 15	11 15	6 23
May	20 0	15 8
3 0	28 9	

X Cygni 192.

(6ᵈ 19ʰ.)

Jan.	May	Sept.
d h	d h	d h
17 7	11 0	2 17
	27 9	19 3
Feb.		Oct.
2 16	June	5 12
19 1	12 19	21 21
Mar.	29 4	Nov.
6 11	July	7 7
22 20	15 13	23 16
Apr.	31 23	Dec.
8 5	Aug.	10 1
24 15	17 8	26 11

T Vulpec. 200.

(1ᵈ 7ʰ.)

Jan.	Mar.	May
d h	d h	d h
1 18	12 18	22 17
6 5	17 4	27 4
10 15	21 15	31 14
15 2	26 1	June
19 12	30 12	5 1
23 22	Apr.	9 11
28 9	3 22	13 21
Feb.	8 8	18 8
1 19	12 19	22 18
6 6	17 5	27 5
10 16	21 16	July
15 3	26 2	1 15
19 13	30 13	6 2
24 0	May	10 12
28 10	4 23	14 23
Mar.	9 10	19 9
3 21	13 20	23 20
8 7	18 6	28 6

T Vulpec. 200 (*continued*).

Aug.	Sept.	Nov.
d h	d h	d h
1 17	23 22	11 17
6 3	28 9	16 4
10 14	Oct.	20 14
15 0	2 19	25 1
19 11	7 6	29 11
23 21	11 16	Dec.
28 7	16 3	3 22
Sept.	20 13	8 8
1 18	25 0	12 19
6 4	29 10	17 5
10 15	Nov.	21 16
15 1	2 20	26 2
19 12	7 7	30 13

δ Cephei 215.

(1ᵈ 15ʰ.)

Jan.	Mar.	June
d h	d h	d h
3 3	29 0	12 3
8 12	Apr.	17 12
13 21	3 8	22 20
19 5	8 17	28 5
24 14	14 2	July
29 23	19 11	3 14
Feb.	24 20	8 23
4 8	30 4	14 7
9 17	May	19 16
15 1	5 13	25 1
20 10	10 22	30 10
25 19	16 7	Aug.
Mar.	21 16	4 19
2 4	27 0	10 3
7 12	June	15 12
12 21	1 9	20 21
18 6	6 18	26 6
23 15		31 15

δ Cephei 21

(*continued*).

Sept.	Oct.
d h	d h
5 23	13 13
11 8	18 22
16 17	24 6
22 2	29 15
27 11	Nov.
Oct.	4 0
2 19	9 9
8 4	14 18

W Cephei 2

(3ᵈ 0ʰ.)

Jan.	May
d h	d h
1 19	3 3
8 5	9 13
14 16	16 1
21 2	22 12
27 12	28 22
Feb.	June
2 23	4 8
9 10	10 19
15 21	17 5
22 7	23 16
28 17	30 2
Mar.	July
6 4	6 12
12 14	13 0
19 2	19 11
25 12	25 22
31 22	Aug.
Apr.	1 8
7 9	7 18
13 19	14 5
20 7	20 15
26 17	27 2

Magnetic Elements, Royal Observatory, Greenwich.

Year.	Declination.	Horizontal force.	Dip.
	° ′		° ′
1870, observed	19 53 west.	0·1782	67 52
1880, „	18 33 „	0·1804	67 36
1890, „	17 29 „	0·1823	67 23
1896, inferred	16 52 „	0·1833	67 14

The horizontal force is given in C. G. S. measure.

MINIMA OF VARIABLE STARS OF THE ALGOL TYPE.

(The figures following star's name are the Nos. in Catalogue, pp. 25–26.)

U Cephei 7*.

($2^d\ 11^h\ 50^m$.)

	d	h	m
Jan.	2	14	5
	7	13	45
	12	13	24
	17	13	3
	22	12	42
	27	12	21
Feb.	1	12	1
	6	11	40
	11	11	19
	16	10	58
	21	10	39
	26	10	17
March.	2	9	56
	7	9	35
	12	9	14
	17	8	53
	22	8	33
	27	8	12
April.	1	7	51
	6	7	30
	11	7	9
	16	6	49
	21	6	28
	26	6	7
May.	1	5	46
	6	5	25
	11	5	5
	16	4	44
	21	4	23
	26	4	2
	31	3	41
June.	5	3	20
	10	3	0
	15	2	39
	20	2	18
	25	1	57
	30	1	36
July.	5	1	16
	10	0	55
	15	0	34
	20	0	13
	24	23	52
	29	23	31
August.	3	23	11
	8	22	50
	13	22	29
	18	22	8
	23	21	47
	28	21	27
Sept.	2	21	6
	7	20	45
	12	20	24
	17	20	3
	22	19	42
	27	19	22
Oct.	2	19	1
	7	18	40
	12	18	19
	17	17	58
	22	17	37
	27	17	17
Nov.	1	16	56
	6	16	35
	11	16	14
	16	15	53
	21	15	32
	26	15	12
Dec.	1	14	51
	6	14	30
	11	14	9
	16	13	48
	21	13	27
	26	13	6
	31	12	46

Algol 20*.

($2^d\ 20^h\ 49^m$.)

	d	h	m
Jan.	2	23	56
	8	17	34
	14	11	11
	20	4	49
	25	22	27
	31	16	5
Feb.	6	9	43
	12	3	20
	17	20	58
	23	14	36
	29	8	14
March.	6	1	51
	11	19	29
	17	13	7
	23	6	45
	29	0	22
April.	3	18	0
	9	11	38
	15	5	16
	20	22	54
	26	16	31
June.	23	0	49
	28	18	27
July.	4	12	5
	10	5	42
	15	23	20
	21	16	58
	27	10	36
August.	2	4	13
	7	21	51
	13	15	29
	19	9	7
	25	2	45
	30	20	22
Sept.	5	14	0
	11	7	38
	17	1	16
	22	18	53
	28	12	31
Oct.	4	6	9
	9	23	47
	15	17	24
	21	11	2
	27	4	40
Nov.	1	22	18
	7	15	56
	13	9	33
	19	3	11
	24	20	49
	30	14	27
Dec.	6	8	4
	12	1	42
	17	19	20
	23	12	58
	29	6	35

λ Tauri 23*.

($3^d\ 22^h\ 52^m$.)

	d	h	m
Jan.	2	8	59
	10	6	43
	18	4	27
	26	2	12
Feb.	2	23	56
	10	21	41
	18	19	25
	26	17	9
March.	5	14	54
	13	12	38
	21	10	23
	29	8	7
July.	6	3	52
	14	1	36
	21	23	21
	29	21	5

λ Tauri 23*

(*continued*).

	d	h	m
August.	6	18	50
	14	16	34
	22	14	18
	30	12	3
Sept.	7	9	47
	15	7	32
	23	5	16
Oct.	1	3	0
	9	0	45
	16	22	29
	24	20	14
Nov.	1	17	58
	9	15	42
	17	13	27
	25	11	11
Dec.	3	8	56
	11	6	40
	19	4	24
	27	2	9

R Canis Maj. 48†.

$$\left\{\begin{array}{l}1=1^d\ 3^h\ 16^m.\\ 2=2\ \ 6\ \ 31\end{array}\right\}$$

	d	h	m
Jan.	2	0	20
	5	10	8
	8	19	55
	12	5	42
	15	15	30
	19	1	17
	22	11	4
	25	20	51
	29	6	39
Feb.	1	16	26
	5	2	13
	8	12	1
	11	21	48
	15	7	35
	18	17	23
	22	3	10
	25	12	57
	28	22	44
March.	3	8	32
	6	18	19
	10	4	6
	13	13	54
	16	23	41
	20	9	28
	23	19	16
	27	5	3
	30	14	50
April.	3	0	37
	6	10	25
	9	20	12
	13	5	59
	16	15	47
	20	1	34
	23	11	21
	26	21	9
	30	6	56
May.	3	16	43
	7	2	30
	10	12	18
	13	22	5
	17	7	52
	20	17	40
	24	3	27
	27	13	14

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* Alternate minima only are given; the others can be readily found by adding the interval under the name of the star.

† Every third minimum only.

Minima of Variable Stars of the Algol Type (continued).

R CANIS MAJ. 48†
(*continued*).

Month	d	h	m
Sept.	3	9	6
	6	18	53
	10	4	41
	13	14	28
	17	0	15
	20	10	2
	23	19	50
	27	5	37
	30	15	24
Oct.	4	1	12
	7	10	59
	10	20	46
	14	6	34
	17	16	21
	21	2	8
	24	11	55
	27	21	43
	31	7	30
Nov.	3	17	17
	7	3	5
	10	12	52
	13	22	39
	17	8	27
	20	18	14
	24	4	1
	27	13	48
	30	23	36
Dec.	4	9	23
	7	19	10
	11	4	58
	14	14	45
	18	0	32
	21	10	20
	24	20	7
	28	5	54
	31	15	41

S CANCRI 63.

Month	d	h	m
Jan.	8	17	6
	18	4	44
	27	16	22
Feb.	6	3	59
	15	15	37
	25	3	15
March.	5	14	53
	15	2	30
	24	14	8
April.	3	1	46
	12	13	24
	22	1	1
May.	1	12	39
	11	0	17
	20	11	55
	29	23	32
June.	8	11	10
	17	22	48
	27	10	26
July.	6	22	3
	16	9	41
	25	21	19
Sept.	1	19	50
	11	7	28
	20	19	5
	30	6	43
Oct.	9	18	21
	19	5	59
	28	17	36
Nov.	7	5	14
	16	16	52
	26	4	30
Dec.	5	16	7
	15	3	45
	24	15	23

δ LIBRÆ 112*.
($2^d\ 7^h\ 51^m$.)

Month	d	h	m
Jan.	2	13	43
	7	5	26
	11	21	8
	16	12	51
	21	4	34
	25	20	17
	30	12	0
Feb.	4	3	42
	8	19	25
	13	11	8
	18	2	51
	22	18	33
	27	10	16
March.	3	1	59
	7	17	42
	12	9	24
	17	1	7
	21	16	50
	26	8	33
	31	0	15
April.	4	15	58
	9	7	41
	13	23	24
	18	15	6
	23	6	49
	27	22	32
May.	2	14	15
	7	5	57
	11	21	40
	16	13	23
	21	5	6
	25	20	49
	30	12	31
June.	4	4	14
	8	19	57
	13	11	40
	18	3	22
	22	19	5
	27	10	48
	29	18	39
July.	4	10	22
	9	2	5
	13	17	48
	18	9	30
	23	1	13
	27	16	56
August.	1	8	39
	6	0	21
	10	16	4
	15	7	47
	19	23	30
	24	15	12
	29	6	55
Sept.	2	22	38
	7	14	21
	12	6	3
	16	21	46
	21	13	29
	26	5	12
Dec.	2	17	2
	7	8	44
	12	0	27
	16	16	10
	21	7	53
	25	23	35
	30	15	18

U CORONÆ 117*
($3^d\ 10^h\ 51^m$.)

Month	d	h	m
Jan.	2	12	16
	9	9	58
	16	7	41
	23	5	23
	30	3	5
Feb.	6	0	47
	12	22	29
	19	20	11
	26	17	53

U CORONÆ 117*
(*continued*).

Month	d	h	m
March.	4	15	35
	11	13	17
	18	10	59
	25	8	41
April.	1	6	23
	8	4	6
	15	1	48
	21	23	30
	28	21	12
May.	5	18	54
	12	16	36
	19	14	18
	26	12	0
June.	2	9	42
	9	7	24
	16	5	6
	23	2	48
	30	0	30
July.	6	22	13
	13	19	55
	20	17	37
	27	15	19
August.	3	13	1
	10	10	43
	17	8	25
	24	6	7
	31	3	49
Sept.	7	1	31
	13	23	13
	20	20	55
	27	18	38
Oct.	4	16	21
	11	14	3
	18	11	45
	25	9	27
Nov.	1	7	9
	8	4	51
	15	2	33
	22	0	15
	28	21	57
Dec.	5	19	39
	12	17	21
	19	15	3
	26	12	45

U OPHIUCHI 151‡.

$$\left\{\begin{array}{l} 1 = 0^d\ 20^h\ 8^m \\ 2 = 1\ \ 16\ \ 16 \\ 3 = 2\ \ 12\ \ 23 \end{array}\right\}$$

Month	d	h	m
Jan.	1	18	33
	5	3	4
	8	11	34
	11	20	5
	15	4	36
	18	13	7
	21	21	38
	25	6	9
	28	14	40
	31	23	10
Feb.	4	7	41
	7	16	12
	11	0	43
	14	9	14
	17	17	45
	21	2	16
	24	10	47
	27	19	17
March.	2	3	48
	5	12	19
	8	20	50
	12	5	21
	15	13	52
	18	22	23
	22	6	53
	25	15	24
	28	23	55

* Alternate minima only are given; the others can be readily found by adding the interval under the name of the star.

† Every third minimum only.

‡ *Every fourth* minimum only.

Minima of Variable Stars of the Algol Type (continued).

U OPHIUCHI 151 ‡ (*continued*).

April.

d	h	m
1	8	26
4	16	57
8	1	28
11	9	59
14	18	30
18	3	0
21	11	31
24	20	2
28	4	33

May.

d	h	m
1	13	4
4	21	35
8	6	6
11	14	36
14	23	7
18	7	38
21	16	9
25	0	40
28	9	11
31	17	42

June.

d	h	m
4	2	13
7	10	43
10	19	14
14	3	45
17	12	16
20	20	47
24	5	18
27	13	49
30	22	20

July.

d	h	m
4	6	50
7	15	21
10	23	52
14	8	23

July.

d	h	m
17	16	54
21	1	25
24	9	56
27	18	27
31	2	57

August.

d	h	m
3	11	28
6	19	59
10	4	30
13	13	1
16	21	32
20	6	3
23	14	34
26	23	4
30	7	35

Sept.

d	h	m
2	16	6
6	0	37
9	9	8
12	17	39
16	2	10
19	10	41
22	19	11
26	3	42
29	12	13

Oct.

d	h	m
2	20	44
6	5	15
9	13	46
12	22	17
16	6	48
19	15	18
22	23	49
26	8	20
29	16	51

Y CYGNI 201 ‡.

$$\left\{\begin{array}{l} 1 = 1^{h}\ 2^{m}\ 48^{s} \\ 2 = 2\ 23\ 55 \\ 3 = 4\ 2\ 43 \end{array}\right\}$$

Jan.

d	h	m
2	13	37
8	13	27
14	13	17
20	13	7
26	12	57

Feb.

d	h	m
1	12	47
7	12	36
13	12	26
19	12	16
25	12	6

Y CYGNI 201 ‡ (*continued*).

March.

d	h	m
2	11	56
8	11	46
14	11	35
20	11	25
26	11	15

April.

d	h	m
1	11	5
7	10	55
13	10	45
19	10	34
25	10	24

May.

d	h	m
1	10	14
7	10	4
13	9	54
19	9	44
25	9	34
31	9	23

June.

d	h	m
6	9	13
12	9	3
18	8	53
24	8	43
30	8	33

July.

d	h	m
6	8	22
12	8	12
18	8	2
24	7	52
30	7	42

August.

d	h	m
5	7	32
11	7	21
17	7	11
23	7	1
29	6	51

Sept.

d	h	m
4	6	41
10	6	31
16	6	20
22	6	10
28	6	0

Oct.

d	h	m
4	5	50
10	5	40
16	5	30
22	5	19
28	5	9

Nov.

d	h	m
3	4	59
9	4	49
15	4	39
21	4	29
27	4	19

Dec.

d	h	m
3	4	8
9	3	58
15	3	48
21	3	38
27	3	28

S ANTLIÆ 68 §.

Jan.

d	h	m
1	3	44
4	9	32
7	15	20
10	21	8
14	2	56
17	8	44
20	14	32
23	20	20
27	2	8
30	7	56

Feb.

d	h	m
2	13	44
5	19	32
9	1	20
12	7	8
15	12	56
18	18	44
22	0	32
25	6	20
28	12	8

S ANTLIÆ 68 § (*continued*).

March.

d	h	m
2	17	56
5	23	44
9	5	32
12	11	20
15	17	8
18	22	56
22	4	44
25	10	32
28	16	20
31	22	8

April.

d	h	m
4	3	56
7	9	44
10	15	32
13	21	20
17	3	8
20	8	56
23	14	44
26	20	32
30	2	20

May.

d	h	m
3	8	8
6	13	56
9	19	44
13	1	32
16	7	20
19	13	8
22	18	56
26	0	44
29	6	32

June.

d	h	m
1	12	20
4	18	8
7	23	56
11	5	44
14	11	32
17	17	20
20	23	8
24	4	56
27	10	44
30	16	32

July.

d	h	m
3	22	20
7	4	8
10	9	56

July.

d	h	m
13	15	44
16	21	32
20	3	20
23	9	8
26	14	56

Sept.

d	h	m
3	12	32
6	18	20
10	0	8
13	5	56
16	11	44
19	17	32
22	23	20
26	5	8
29	10	56

Oct.

d	h	m
2	16	44
5	22	32
9	4	20
12	10	8
15	15	56
18	21	44
22	3	32
25	9	20
28	15	8
31	20	56

Nov.

d	h	m
4	2	44
7	8	32
10	14	20
13	20	8
17	1	56
20	7	44
23	13	32
26	19	20
30	1	8

Dec.

d	h	m
3	6	56
6	12	44
9	18	32
13	0	20
16	6	8
19	11	56
22	17	44
25	23	32
29	5	20

‡ Every fourth minimum only.

§ Every tenth minimum only; the others may be found by adding the multiples of period in the following table:—

P.	h m	P.	d h m	P.	d h m
1	7 47	4	1 7 7	7	2 6 28
2	15 34	5	1 14 54	8	2 14 14
3	23 20	6	1 22 41	9	2 22 1

MAXIMA AND MINIMA OF VARIABLE STARS.

The No. refers to Catalogue on pp. 25–26; M signifies maximum; *m*, minimum

January.

d	No.	
1	171	M
2	102	M
4	122	M
	183	*m*
5	133	M
	89	*m*
	49	M
	6	M
7	203	M
	88	M
	222	M
	208	M
8	50	*m*
12	74	M
	27	M
	34	M
13	159	M
14	178	M
	138	M
	24	M
	19	*m*
16	78	*m*
	176	M
17	118	M
23	14	*m*
24	45	*m*
26	50	M
	109	*m*
	195	*m*
27	165	*m*
28	211	M
29	131	M
	197	M
	129	M
30	54	*m*
31	162	*m*

February.

d	No.	
1	74	*m*
	135	*m*
2	194	M
3	147	M
	150	*m*
	223	M
5	10	M
	12	M
8	26	M
	170	*m*
9	125	M
	202	M
13	172	M
	191	*m*
14	187	*m*
15	91	*m*
	72	*m*
16	74	M
17	168	M
19	87	*m*
	165	M
	73	*M*
	76	*m*
	188	*M*

February (*con.*).

d	No.	
20	104	M
22	99	*m*
	141	M
	25	M
	50	*m*
23	200	*m*
24	96	M
26	176	*m*
27	221	*m*
	47	M
	111	M
28	18	*m*
29	43	*m*

March.

d	No.	
1	29	*m*
	189	*m*
	210	*m*
	187	M
	131	*m*
2	186	*m*
5	208	*m*
6	162	M
7	65	M
	74	*m*
8	37	M
9	157	M
	214	M
11	196	M
	185	*m*
12	167	M
13	106	M
	89	M
14	13	M
	165	*m*
16	121	M
17	120	M
	22	M
	219	*m*
18	24	*m*
20	3	*m*
21	206	*m*
	32	M
	220	M
22	74	M
	107	M
	175	*m*
23	176	M
25	140	*m*
	17	*m*
27	128	M
	16	*m*
	89	M
	11	M
28	122	*m*
31	35	*m*

April.

d	No.	
2	*30*	*m*
3	*104*	*m*
	38	*m*

April (*con.*).

d	No.	
4	217	M
	115	M
5	55	M
6	39	M
	101	M
	165	M
7	33	*m*
	50	*m*
8	77	M
10	5	*m*
11	74	*m*
	92	*m*
	162	*m*
	105	*m*
	102	*m*
12	182	*m*
13	152	M
14	161	M
	114	*m*
	169	*m*
15	204	M
16	139	*m*
17	28	M
19	118	*m*
23	71	M
24	14	M
	108	*m*
	187	*m*
25	81	M
	176	M
	50	M
26	74	M
28	191	M
29	224	*m*
30	165	*m*
	131	M

May.

d	No.	
1	145	M
3	176	*m*
4	206	M
	66	*m*
	174	*m*
	10	*m*
6	109	M
10	187	M
	127	*m*
12	180	M
13	47	*m*
14	87	M
15	76	M
16	74	*m*
	126	M
	162	M
17	2	M
	208	M
19	148	M
20	19	M
21	199	M
22	1	*m*

May (*con.*).

d	No.	
22	185	M
	50	*m*
23	165	M
24	45	M
	111	*m*
	207	M
	4	M
	51	*m*
25	119	M
26	222	*m*
27	49	*m*
	183	M
28	195	M
	170	M
	186	M
29	89	*m*
	29	M
	97	M
30	176	M
31	59	*m*
	74	M
	31	M

June.

d	No.	
1	88	*m*
2	131	*m*
	136	M
3	157	*m*
	213	M
	197	*m*
4	24	M
	172	*m*
5	26	*m*
	16	M
	54	M
7	91	M
9	137	M
	50	M
10	6	*m*
	191	M
	102	M
12	203	M
	11	*m*
13	123	M
14	194	M
15	147	*m*
16	134	M
	122	M
17	165	*m*
20	74	*m*
21	104	M
	162	*m*
	124	M
22	95	M
24	53	*m*
26	135	M
	18	M
	202	M
30	175	M

July.

d	No.	
1	82	M
2	150	M
	81	*m*
4	188	*m*
	187	*m*
5	110	M
	74	M
	8	M
6	22	*m*
7	50	*m*
	197	M
8	92	M
	36	M
	98	M
9	165	M
10	176	*m*
	64	M
11	177	M
	75	M
12	47	M
13	197	M
	9	*m*
14	208	*m*
	15	*m*
16	143	M
17	76	*m*
19	13	*m*
20	187	M
21	43	M
25	50	M
	205	*m*
	46	*m*
	74	*m*
	17	M
26	162	M
	10	M
27	209	*m*
	14	*m*
28	118	M
	114	M
29	132	M
30	58	*m*
	108	M

August.

d	No.	
1	131	M
2	165	*m*
	104	*m*
3	72	M
	107	*m*
4	100	M
5	185	*m*
	89	M
6	176	M
	61	M
7	73	*m*
	24	*m*
8	172	M
9	74	M
10	99	M
	214	M
14	26	M
15	182	M

August (*con.*).

d	No.	
16	32	*m*
17	29	*m*
	12	*m*
	34	*m*
19	105	M
20	157	M
	84	M
21	50	*m*
	194	*m*
22	111	M
24	221	M
	212	M
25	25	*m*
	165	M
28	35	M
29	74	*m*
31	162	*m*

September.

d	No.	
2	5	M
	131	*m*
4	178	*m*
5	219	M
6	167	*m*
7	109	*m*
8	122	*m*
	50	M
	140	M
10	59	M
	202	*m*
	16	*m*
	135	*m*
12	220	M
	187	*m*
13	74	M
14	199	*m*
15	57	M
	207	*m*
16	176	*m*
	52	M
17	88	M
18	218	M
	165	*m*
19	102	*m*
	169	M
24	91	*m*
	87	*m*
25	208	M
26	170	*m*
	186	*m*
27	47	*m*
	149	M
	195	*m*
28	187	M
	175	*m*
29	71	*m*
30	205	M

October.

d	No.	
1	174	M
3	74	*m*
4	139	M

October (*con.*).

d	No.	
5	50	*m*
	147	M
	162	M
7	145	*m*
8	49	M
	6	M
	127	M
11	165	M
	76	M
	22	M
12	96	*m*
	211	M
	176	M
	40	M
13	184	M
16	185	M
	189	M
	224	M
18	74	M
19	148	*m*
20	104	M
21	89	*m*
	223	M
	161	*m*
	11	M
23	50	M
	77	*m*
24	121	M
	37	*m*
	24	M
	10	*m*
25	78	M
27	14	M
	210	M
	3	M
28	118	*m*
	21	M
29	1	M
31	142	M

November.

d	No.	
1	39	*m*
	129	M
	131	M
2	30	M
3	15	M
4	165	*m*
	92	*m*
	51	M
	81	M
7	74	*m*
10	162	*m*
11	202	M
12	190	*m*
14	157	*m*
	29	M
16	203	M
	197	*m*
	18	*m*
	17	*m*
	111	*m*

November (*con.*).

d	No.	
16	191	*m*
17	120	*m*
	126	*m*
18	102	M
	198	M
19	204	M
	54	*m*
	16	M
	183	*m*
	50	*m*
21	38	*m*
	133	M
	187	*m*
22	208	*m*
	19	*m*
	176	*m*
	74	M
26	180	*m*
	47	M
	165	M
27	122	M
28	172	*m*
30	125	M

December.

d	No.	
1	188	M
2	58	M
	150	*m*
	104	*m*
	137	M
4	33	M
	131	*m*
7	46	M
	50	M
	187	M
8	114	*m*
9	26	*m*
10	138	M
11	79	M
	199	M
12	32	M
	74	*m*
13	76	*m*
15	162	M
16	208	M
	53	M
	107	M
17	109	M
18	87	M
19	176	M
20	165	*m*
	159	M
21	65	M
22	186	M
26	197	M
27	24	*m*
	74	M
28	89	M
29	73	M
30	185	*m*
31	13	M

DOUBLE STARS.

No.	Star's name.	R.A. 1900.	Dec. 1900.	Mag.	Pos.-angle.	Distance.	Epoch. 1890+.	Observer.
		h m	° ′		°	″		
1.	Σ 3062	0 0·9	+57 52	6½ ; 7½	332·9	1·86	4·64	G.
2.	Σ 13	0 10·3	+76 24	6½ ; 7	87·3	0·97	3·00	G.
3.	OΣ 12, λ Cassiop.	0 26·4	+53 58	6½ ; 6½	154·9	0·30	3·03	G.
4.	OΣ 18	0 37·2	+ 3 36	7½ ; 9½	127·2	1·47	4·83	B.
5.	β 866	0 39·1	+42 34	9 ; 9	69·6	1·39	1·83	β.
6.	Σ 60, η Cassiop.	0 43·0	+57 17	3½ ; 7½	202·9	4·65	5·72	M.
7.	OΣ 20, 66 Piscium ...	0 49·2	+18 29	6 ; 6	328·9	0·36	4·85	Ls.
8.	Σ 73, 36 Andromedæ .	0 50·1	+23 2	6 ; 6½	15·8	1·41	4·88	Ls.
9.	Σ 113, 42 Ceti	1 14·3	− 1 3	6½ ; 7	349·7	1·68	4·88	Ls.
10.	Σ 138	1 30·8	+ 7 7	7 ; 7½	216·8	1·66	3·86	Ls.
11.	*p* Eridani	1 35·7	−56 0	6 ; 6	226·6	7·02	2·92	T.
12.	Σ 185	1 51·8	+75 1	7 ; 8½	29·9	1·31	1·66	β.
13.	Σ 202, α Piscium	1 56·8	+ 2 17	4 ; 5	322·8	3·03	2·74	G.
14.	Σ 205, γ Androm. AB.	1 57·8	+41 51	2½ ; 5½	63·2	10·33	5·88	Ls.
15.	Σ 208, 10 Arietis	1 57·9	+25 27	6½ ; 8½	46·7	1·71	0·03	Kn.
16.	Σ 262, ι Cassiop. AB .	2 20·8	+66 53	4½ ; 7	253·3	2·27	4·14	Kn.
17.	Σ 333, ε Arietis	2 53·5	+20 56	5½ ; 6	203·9	1·44	4·03	Kn.
18.	OΣ 50	3 1·5	+71 4	7 ; 7	205·9	1·27	3·21	M.
19.	Σ 367	3 8·3	+ 0 22	7½ ; 7½	230·7	0·66	0·10	T.
20.	Σ 412, 7 Tauri	3 28·5	+24 8	6½ ; 7	213·2	0·45	5·05	Ls.
21.	Σ 422	3 31·8	+ 0 16	6 ; 8	244·9	6·25	3·09	M.
22.	Σ 425	3 33·8	+23 42	7½ ; 8	92·7	3·00	4·19	M.
23.	Σ 460	3 53·2	+80 25	6 ; 7	43·8	0·96	3·21	M.
24.	Σ 511	4 9·5	+58 33	7 ; 7½	273·3	0·39	0·94	H.
25.	Σ 518, o² Eridani	4 10·6	− 7 49	8½ ; 10½	97·4	2·48	1·78	β.
26.	OΣ 79, 55 Tauri	4 14·2	+16 17	6½ ; 8	87·9	0·38	0·67	β.
27.	Σ 535	4 17·7	+11 9	7 ; 8	330·5	2·07	5·06	Ls.
28.	Σ 572	4 32·2	+26 44	6 ; 6	201·9	3·23	3·13	Ls.
29.	OΣ 98, ι Orionis	5 2·4	+8 22	5½ ; 7	188·6	1·05	3·17	Ls.
30.	Σ 742, 380 Tauri	5 30·4	+21 56	7 ; 7½	258·8	3·50	5·16	M.
31.	Σ 749	5 30·9	+26 53	6½ ; 7½	167·4	1·14	3·15	Ls.
32.	Σ 932	6 28·5	+14 49	8 ; 8	328·1	2·34	3·18	Ls.
33.	Σ 945	6 33·3	+41 4	7 ; 8	269·0	0·54	3·24	Ls.
34.	Σ 948, 12 Lyncis AB .	6 37·3	+59 33	6 ; 6½	121·9	1·48	3·21	Ls.
35.	OΣ 159, 15 Lyncis ...	6 48·6	+58 33	5 ; 6	7·5	0·81	1·09	H.
36.	Σ 982, 38 Geminor. ...	6 49·0	+13 18	5½ ; 8	160·7	6·77	3·21	Ls.
37.	Σ 1037	7 6·6	+27 24	7 ; 7	306·9	1·07	3·24	M.
38.	OΣ 170	7 12·2	+ 9 29	7 ; 7½	112·4	0·74	3·15	Ls.
39.	Σ 1066, δ Geminor. ...	7 14·1	+22 10	3 ; 8	206·8	7·37	3·21	Ls.
40.	Σ 1074	7 15·4	+ 0 36	7½ ; 8½	137·4	0·58	5·19	Ls.
41.	Σ 1093	7 22·7	+50 12	8 ; 8½	135·6	0·72	1·20	H.
42.	Σ 1110, Castor	7 28·2	+32 7	2 ; 3	225·0	6·17	5·27	Ls.
43.	OΣ 182	7 47·4	+ 3 39	8½ ; 8½	31·3	1·19	5·19	Ls.
44.	Σ 1187	8 3·2	+32 31	7 ; 8	45·8	2·17	3·15	Ls.
45.	Σ 1196, ζ Cancri AB .	8 6·4	+17 59	5½ ; 7½	21·9	1·20	5·23	Ls.
46.	„ „ AC .	......	......	5½ ; 6½	117·1	5·10	5·23	Ls.
47.	„ „ BC .	......	......	7½ ; 6½	127·9	5·59	5·23	Ls.
48.	β 205	8 28·8	−24 16	7 ; 7	252·6	0·3	3·20	S.
49.	Σ 1263	8 38·6	+42 4	7½ ; 8	20·6	51·42	5·30	Ls.
50.	Σ 1273, ε Hydræ	8 41·5	+ 6 50	4 ; 7	231·4	3·68	5·23	Ls.
51.	Σ 3121	9 11·9	+29 0	7½ ; 7½	190·5	0·65	5·23	Ls.
52.	Σ 1338	9 14·7	+38 37	7 ; 7½	165·7	1·52	3·28	Ls.
53.	OΣ 201	9 18·0	+28 20	7 ; 11	223·3	1·40	5·31	Ls.
54.	Σ 1348	9 19·3	+ 6 58	7 ; 8	319·5	1·61	5·31	Ls.
55.	Σ 1356, ω Leonis	9 23·1	+ 9 30	5½ ; 7	108·4	0·72	5·19	Ls.
56.	Σ 1417	10 9·5	+19 40	8½ ; 8½	257·7	2·56	2·29	M.
57.	OΣ 215, P. x. 23	10 10·9	+18 15	6½ ; 7	209·0	1·01	5·24	Ls.
58.	Σ 1424, γ Leonis	10 14·4	+20 22	2 ; 4	114·2	3·64	5·23	Ls.
59.	Σ 1457	10 33·5	+ 6 16	7½ ; 8	316·3	0·96	3·34	Ls.
60.	OΣ 224	10 34·5	+ 9 22	7 ; 9	321·4	0·47	5·22	Ls.

DOUBLE STARS (*continued*).

No.	Star's name.	R.A. 1900.	Dec. 1900.	Mag.	Pos.-angle.	Distance.	Epoch 1890+.	Observer.
		h m	° '		°	"		
61.	OΣ 229	10 42·3	+41 38	6 ; 7	322·9	0·83	2·44	M.
62.	Σ 1523, ξ Ursæ Maj.	11 12·9	+32 6	4 ; 5	176·0	1·98	5·33	Ls.
63.	Σ 1536, ι Leonis	11 18·7	+11 5	4½ ; 7½	56·9	2·73	5·44	Ls.
64.	OΣ 235	11 26·7	+61 38	5½ ; 7	84·3	0·97	2·12	β.
65.	Σ 1606	12 5·7	+40 27	6 ; 7	330·2	1·10	5·57	M.
66.	Σ 1647, 191 Virginis	12 25·5	+10 16	7½ ; 8	219·6	1·32	3·36	Ls.
67.	Σ 1670, γ Virginis	12 36·7	− 0 54	3 ; 3	150·3	5·68	4·49	B.
68.	Σ 1687, 35 Comæ	12 48·1	+21 48	5 ; 8	77·0	0·98	5·51	M.
69.	Σ 1728, 42 Comæ	13 5·2	+18 4	5½ ; 6	19·5	0·47	3·41	Ls.
70.	OΣ 266	13 23·6	+16 14	7 ; 8	337·5	1·47	5·35	Ls.
71.	Σ 1757, P. xiii. 127	13 29·3	+ 0 12	7½ ; 8	80·0	2·62	3·42	Ls.
72.	Σ 1768, 25 Can. Ven.	13 33·2	+36 48	6 ; 8	144·1	0·93	5·51	M.
73.	Σ 1785	13 44·5	+27 29	7½ ; 8	257·6	1·67	4·58	G.
74.	Σ 1788	13 49·7	− 7 34	6½ ; 7½	76·1	2·60	1·12	M.
75.	Σ 1819	14 10·3	+ 3 36	7½ ; 7½	185·4	1·38	4·52	M.
76.	Σ 1865, ζ Boötis	14 36·3	+14 10	4 ; 4	284·7	0·53	3·49	Ls.
77.	Σ 1877, ε Boötis	14 30·6	+27 30	8 ; 8	336·6	3·21	5·43	Ls.
78.	Σ 1879	14 41·3	+10 4	8 ; 8½	144·6	0·40	5·44	Ls.
79.	Σ 1888, ξ Boötis	14 46·7	+19 31	5 ; 7	228·2	2·85	5·49	M.
80.	β 31	14 47·8	+19 9	8½ ; 9½	195·2	1·85	5·45	Ls.
81.	OΣ 287	14 47·9	+45 20	7 ; 8	321·9	0·94	3·49	Ls.
82.	β 119	15 0·0	− 6 36	8 ; 8½	307·1	1·47	2·35	L.
83.	β 350	15 8·2	−27 10	7 ; 8½	160·2	1·15	2·41	L.
84.	Σ 1932, 1 Cor. Bor.	15 14·0	+27 13	6½ ; 7	317·3	0·94	3·50	Ls.
85.	Σ 1937, η Cor. Bor.	15 19·1	+30 40	6 ; 6	245·3	0·85	3·50	Ls.
86.	Σ 1938, μ^2 Boötis	15 20·7	+37 22	6½ ; 7½	84·6	0·97	5·51	M.
87.	OΣ 298	15 32·4	+40 8	7 ; 7½	170·6	1·03	3·46	Ls.
88.	Σ 1967, γ Cor. Bor.	15 38·5	+26 36	4 ; 7	123·5	0·53	4·50	Ls.
89.	OΣ 303	15 56·2	+13 33	7 ; 7½	139·9	0·97	1·52	M.
90.	Σ 1998, ξ Scorpii	15 58·8	−11 5	5 ; 5½	207·5	1·00	4·59	G.
91.	Σ 2032, σ Coronæ	16 11·1	+34 7	6 ; 6½	209·8	4·24	3·62	M.
92.	Σ 2055, λ Ophiuchi	16 25·8	+ 2 12	4½ ; 5½	43·6	1·25	5·43	Ls.
93.	Σ 2084, ζ Herculis	16 37·5	+31 47	3 ; 6½	37·9	0·67	5·44	Ls.
94.	Σ 2107, 167 Herculis	16 47·8	+28 50	7 ; 8½	286·8	0·49	5·53	Ls.
95.	Σ 2140, α Herculis	17 10·1	+14 30	2½ ; 6	115·8	4·99	5·51	Ls.
96.	Σ 2173, 221 Ophiuchi	17 25·5	− 0 59	6 ; 6	336·8	1·14	4·54	Ls.
97.	OΣ 338	17 47·4	+15 21	6½ ; 6½	17·3	0·74	5·72	Ls.
98.	Σ 2262, τ Ophiuchi	17 57·6	− 8 11	5 ; 6	253·9	1·84	3·47	M.
99.	Σ 2272, 70 Ophiuchi	18 0·4	+ 2 32	4 ; 6	296·9	2·26	5·56	M.
100.	OΣ 358	18 31·3	+16 54	6½ ; 7	197·3	1·98	5·66	Ls.
101.	β 648	18 54·2	+23 39	6 ; 9	237·9	1·59	5·59	Ls.
102.	γ Coronæ Aust.	19 0·0	−37 12	5½ ; 5½	166·5	1·13	3·68	S.
103.	β 248	19 13·4	+22 51	6 ; 9	125·4	1·86	0·63	β.
104.	Σ 2579, δ Cygni	19 41·8	+44 53	3 ; 8	211·9	2·71	4·56	G.
105.	Σ 2695	20 27·7	+25 28	6 ; 8	81·6	1·07	5·72	Ls.
106.	β 151, β Delphini	20 32·7	+14 15	3½ ; 5½	338·7	0·65	5·81	Ls.
107.	Σ 2729	20 46·3	− 5 59	6½ ; 6½	185·5	0·55	2·70	T.
108.	Σ 2799	21 23·9	+10 38	7 ; 7½	119·4	1·22	5·72	Ls.
109.	Σ 2822, μ Cygni	21 39·7	+28 18	4 ; 5	123·2	2·91	5·75	Ls.
110.	Σ 2909, ζ Aquarii	22 23·7	− 0 32	4 ; 4	322·9	3·38	5·85	M.
111.	Σ 2944, AB	22 42·7	− 4 45	7 ; 7½	255·5	3·50	2·76	M.
112.	OΣ 483, 52 Pegasi	22 54·2	+11 12	6 ; 7½	216·9	1·10	1·29	M.
113.	β 79	23 11·8	− 2 9	8 ; 8½	94·6	0·88	1·54	β.
114.	β 80	23 13·2	+ 4 53	8 ; 8½	325·1	0·64	4·85	Ls.
115.	OΣ 547	0 0·4	+45 16	8 ; 8	340·8	4·30	1·73	H.

In the column headed "Observer," the following abbreviations are used:—

L. Leavenworth.
Ls. Lewis.
β. Burnham.

B. Bijourdan.
G. Glasenapp.
T. Tebbutt.

Kn. Knorre.
M. Maw.
H. Hall.

S. Sellors.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 236. JANUARY. 1896.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, December 13, 1895.

Dr. A. A. Common, F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. Turner, M.A., B.Sc., and E. W. Maunder.

The Minutes of the last Meeting were read and confirmed.

Mr. Maunder. 83 presents have been received since the date of the last Meeting. Among these is an original negative of the Moon, and an enlargement showing a portion only of the lunar surface, taken with the 36-in. telescope at the Lick Observatory; some extremely beautiful negatives of Saturn, also from the Lick Observatory. We have also a remarkable photograph of a meteor, presented by Mr. C. P. Butler, and a photograph of the cluster in Hercules by Mr. W. E. Wilson of Daramona, Westmeath.

The photographs mentioned were then exhibited on the screen. Mr. A. Fowler explained the circumstances relating to the photograph of the meteor, which had been accidentally photographed on a plate exposed for another purpose near South Kensington. The appearance of the meteor as shown on the plate had been corroborated by an eye observer in the neighbourhood.

A vote of thanks was accorded to the donors of the presents.

On the motion of Mr. Wigglesworth, seconded by Mr. Lindemann, Mr. H. P. Hollis, Mr. Sidney Waters, and Dr. Smart were appointed Auditors of the accounts of the Society for the past year.

Prof. Turner read a paper by *Mr. Denning* on "The Radiant-point of the October Meteors." The point of the paper was to show the result of a more close examination of two typical radiant-points—the motion of one of which to the eastward was confirmed, and the other of which similarly was found to be stationary, as shown by many observers.

Mr. E. J. Stone exhibited on the screen a slide showing a photograph of a crayon drawing of the Moon in the possession of the Radcliffe Observatory. The original drawing was made by Mr. John Russell, a Royal Academician, and was dated 1795. It seems that the artist had been induced by Sir Joseph Banks, then President of the Royal Society, who thought it would be valuable to have a picture of the Moon drawn by an experienced draughtsman, to take up this subject, and Mr. Russell devoted much of the remainder of his life to this work. There are drawings of portions of the Moon at the Radcliffe Observatory made during a period of over 18 years, and from these the picture was compiled of which a photograph is now exhibited Mr. Stone found that the portions of the picture which were injured by damp when it was first sent to the Observatory appeared to show traces of mildew. The picture was, therefore, dismounted; and he thought it desirable to have it photographed. So far as comparisons have been made, there are no marked differences between the picture and the photographs of the present day.

Mr. N. E. Green. I should like to say how much, as an artist, I admire the drawing.

Mr. McCarthy. I certainly was very much struck with the beauty of the drawing; as thrown upon the screen it looked more like a mezzophoto-engraving. Would Mr. Stone tell us the size of the drawing, and does he know if there are any earlier pictures so good as this?

Mr. Stone. The crayon drawing is 5 feet square. I do not think there are any drawings so good as this of earlier date. There are maps of certain portions of it, but not drawings made by an artist.

The President. I should like to ask Mr. Stone to present the Society with the lantern-slides of the very interesting copy he has shown us. It will be interesting to compare the best results of an artist on the Moon with modern photography. I do not know of any other attempt to give the whole Moon in this way.

Dr. Roberts then read a paper on the "Spiral Nebula M. 33 Trianguli." The photograph was taken with the 20-inch reflector last month, with an exposure of the plate during $2^h\ 15^m$. Sir J. Herschel described the nebula as a remarkable object, extremely bright, extremely large, round, very rich, gradually brighter in the middle, with a nucleus. Lord Rosse had recorded thirty-two observations made between 1849 and 1862. His records and sketch show the difficulty encountered by the observers in their efforts to make it intelligible by descriptive matter and drawings, the object having a structure so complex that no eye or hand, however trained, could possibly delineate it. The photograph showed the nebula to be spiral with remarkable features. The nebula measured about 32′ in the direction *nf.* to *s.p.* and 35′ in the direction *s.f.* to *n.p.* There were two large, very prominent, spiral arms, whose curvatures were approximately symmetrical from their extremities to their point of junction at the centre. There was a very dense nebulous patch surrounding it elongating in the N. and S. direction. Involved in that nebulosity were three bright stars and several nebulous stars. The two arms also were crowded with well-defined stars and faint nebulous stars with nebulosity between them, and it was to the combined effect of these that the defined boundary of the arms was due. Besides those two arms there were subsidiary arms, less well-defined and likewise tending towards the centre. Many of the stars were nebulous and many were well-defined but small, and the spaces between the convolutions were more or less filled with faint nebulosity, having curves, rifts, without apparent nebulosity around them. There was outlying nebulosity with many small, well-defined, and nebulous stars involved in it. There were also isolated nebulous stars in the extreme boundary of the nebula, but the evidence was that they were all related to the nebula. Dr. Roberts went on to say that the photograph would well repay careful study, and was fruitful in suggestions as to the cause and development of such bodies; and on this point he himself was led to make the following suggestions:—It was known with a reasonable amount of certainty that both nebulous and meteoric matter existed in space, and there was some evidence that bodies in space had come into collision. From these premises they might infer that this nebula was the result of a collision of some kind. They could imagine collisions of at least three kinds possible: between two stars, between two nebulæ, or between two swarms of meteorites. In the case of this nebula, which, if any, of the three possibilities mentioned seemed the one most probably to have happened? Much might be said in favour of each of those three suggestions; but the speaker would not at present enter into details, though one could readily imagine that a collision of two swarms of meteorites moving in opposite directions, one from the *s.f.* and the other from the *n.p.* direction, would account for the spiral appearance and rotary motion and the smashed state in which the nebula was shown on the photograph. Two photographs of the nebula had been taken, one on 1891, Nov. 11, and the present one on 1895, Nov. 14. These had been examined, and the nebulosity with all the stars had been found on both plates to be sensibly coincident after the lapse of nearly four years.

A photograph of the spiral nebula 101 Ursæ Majoris was then shown, on which the nebula was seen similar to the preceding, but appeared to have arrived at a more advanced stage of development.

The President. Everyone must admire the beautiful photographs Dr. Roberts shows us from time to time, and I will ask you to return your thanks to him for them. I do not see why Dr. Roberts should limit the number of possible collisions to three kinds. He might have had several combinations of the three kinds of bodies.

Mr. Knobel. Some few weeks ago I wrote to Dr. Roberts, and asked him whether he had taken any photographs of the nebula

M. 33; and the answer I received about ten days ago was this marvellous photograph, and I think our best thanks are due to him for obtaining such a magnificent picture. It seems to me a great achievement. The object is one to which I have paid much attention, and I have also sketched it. It is remarkably interesting in several ways; but I do not think the view on the screen does quite adequate justice to Dr. Roberts's photograph. This afternoon I saw the negative, which is replete with interest and beauty, and the detail which is shown about the nucleus especially is far more than is shown on the lantern-slide. There is a good deal of misconception existing about this nebula. Webb says that it is invisible with a power of 144; whereas I sketched the nucleus twenty-three years ago with a power of 212. I sketched 15 stars in the nebula, and these can be identified in the photograph with one exception. I should be particularly pleased if Dr. Roberts will take a note of that star and see if it can be found in the photograph of 1891, and if so, it is curious that it is not in this recent photograph.

Capt. Noble. Dr. Roberts spoke of collisions of meteorites as a *vera causa,* or, at all events, as an explanation that might be generally accepted of the appearance of this nebula. Fellows of the Society may remember when Dr. Anderson, of Edinburgh, discovered the Nova Aurigæ that that was set down to a collision of two streams of meteors, one of which, giving a dark line spectrum, was approaching us, and the other, whose spectral lines were bright, was receding from us, and a very plausible explanation was worked out to account for the appearance of the spectrum of the star. Then another star was discovered in Norma with the same spectra as Nova Aurigæ, so therefore there must again have been two streams, one going away and the other coming to us. Now a third star is found in Carina by Mrs. Fleming, which also requires us to believe in one stream going away from and another coming towards us, which makes rather a large demand on our credence. It seems to me doubtful that meteors which collide all go straight in the line of sight, and I should like to ask on what authority Dr. Roberts asks us to believe that this nebula has its origin in what he says.

Dr. Roberts. Capt. Noble compares a body which is seen almost as a point of light with a body which occupies a space represented by one degree square in the heavens. I do not make any assertions about streams producing a point of light, nor do I make a positive assertion that it is a thing within my knowledge that this vast smashed-up spiral nebula is absolutely the result of a collision of two streams of meteorites; I simply say there are indications from which we may draw inferences, and I regret that I have no authority superior to the photograph itself that will enable me to say in different language what I am now trying to say. You must take what I say for what it is worth, and if you have a better reason to give nobody will listen with greater pleasure than

I shall if your reason is more plausible than mine. Mr. Knobel has kindly given us the result of his very arduous task in trying to reconcile the appearance of this nebula on the photograph with the appearance as seen by the eye; but I understand that he did not succeed to his own satisfaction. As to the star he calls attention to, I should not have been surprised if there had been a hundred different from what he had delineated 20 years ago. It is not surprising that he was not able to see the details which the photograph shows; but I shall be very pleased to hunt up that missing star, and if I find it will bring the matter again before you on some future occasion.

A vote of thanks was unanimously accorded to Dr. Roberts.

The President. I mentioned at the last meeting that we should probably now have something to say about the solar eclipse of next August. It appears a long time between now and August, but when we consider the preparation of instruments, &c. to use in a distant country it is not too soon to begin. We have had a meeting of the Eclipse Committee to-day, and Prof. Turner has prepared a report. I do not think we shall be breaking any confidence if we read a little of this, and show you one or two instruments which it is proposed to use. There is one which may be new to some Fellows, but the idea itself is 40 or 50 years old, and has lately been revived by M. Lippmann, of Paris, and called by him the cœlostat. For such work as is done during an eclipse this instrument is preeminently adapted. It is very light and very small, and there is no difficulty in adjustment. But one of its chief advantages is that it does not require a large and heavy dome such as is necessary for an equatorially-mounted telescope. The telescope used with it may be very stable and of any focal length, and requires to be housed in a cover only sufficiently large for itself and the observer.

Prof. Turner. One of the most important questions that has been before the Permanent Eclipse Committee, a joint committee of the Royal Society and this Society, has been the provision of heliostats of some form suitable for eclipse work. This question was opened in November of last year, when it was proposed that two heliostats with 16-inch mirrors should be constructed. A modification of the original plan was made in the past summer, when Dr. Johnstone Stoney called the attention of the Committee to this form, called the cœlostat* by M. Lippmann. The form is apparently not new. When I wrote to Sir George Stokes about this form of instrument, he at once called to mind that he had heard of it a good many years ago, and on looking up the literature of the subject I found it had been invented and reinvented many times, but it has not been used for eclipse work, nor can I find any record of work to which it has been put. Mr. Langley had recommended its use some years ago, but his advice was not taken. The Committee have been in communication with Prof. Milne, who has been in Japan for some years. He gives a very favourable report of the conditions in the Northern Island, and was able to recommend to the Committee a very suitable station. That particular station is not selected in the 'Nautical Almanac' circular, but he said he could recommend the site before any other in the neighbourhood. It is proposed that several observers should go to Japan.

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* See 'Observatory,' Vol. xviii. p. 301.

The President. It is proposed to send certain observers to Norway. Messrs. Gaze and Co. will send a ship, the 'Norse King,' there, and have given the Committee the advantage of sending a few observers at a reduced rate. Messrs. Anderson are sending the 'Lusitania,' which will take nearly the same course as the 'Norse King. There are other ways of going, namely from Newcastle to Bergen and by mail-boat to Vadsö. The time of year is most favourable, and only fine weather is needed to make it a very successful expedition. In Japan the climatic conditions seem to be all that can be desired at that time of the year. Capt. Hills is going to Japan, and is looking after the spectroscopic part of the work.

Sir R. Ball. What sized telescopes do you propose to use?

The President. It was felt by the Committee generally that there was strong reason for carrying on the series of observations that had been made with certain lenses during past eclipses for getting the shape of the corona and so on. It does not seem that the time has come to leave off this old series, so the same telescopes that were used at the last and previous eclipses are to be used again. We are also endeavouring to get very long-focus lenses in order to get the image of the inner part of the corona on a larger scale than the short-focus lenses we have been using have given us hitherto.

Dr. Downing. Messrs. Anderson have informed me that they are despatching a ship to get to Vadsö the day before the eclipse and that passengers can come home in the 'Lusitania,' which is timed to drop her passengers five or six days before the eclipse.

Capt. Noble. Mr. Burckhalter, of San Francisco, has devised an exceedingly ingenious arrangement to rotate in front of the photographic plate to effect a graduated exposure on the corona from the limb of the Sun right out to the extremity of the corona. He says he is willing to supply a description of this apparatus to anyone who wishes to use it. This is to enable the whole of the corona to be photographed by one exposure.

The Astronomer Royal. The question arises whether there is any advantage in attempting to get the whole corona in a complete form on one plate; the idea of the Eclipse Committe is to take a number of plates with graduated exposures, so as to give short exposures to the inner, and longer exposures to the outer corona. It will then be possible to judge from the density of the images the true relations of the brightness of the different parts. I am afraid of the other plan, because it is trying to do a little too much on one plate and is therefore liable to failure.

Capt. Noble. Why not do both? Let us have a series of zones of the corona. Mr. Burckhalter authorized me to tell any one who cares to adopt this that he will supply anything that is necessary.

The President. It is no doubt very kind of him to give permission to use this thing, but if he sent the instrument over here and asked us to try it we might possibly be induced to do so. I will ask Capt. Hills to tell us something about the instruments he proposes to use.

Capt. E. H. Hills. Exhibited the instrument he has had made for the eclipse, which is a fine example of the simplest form of heliostat, made by Hammersley. It is comparatively light and perfectly rigid, and driven by a spring clock, which avoided the necessity of carrying heavy weights.

Mr. A. Fowler exhibited photographs of spectra, some taken during the last eclipse, as illustrations of the work it was proposed to attempt next August in Norway.

The Astronomer Royal, in presenting a paper giving observations of Perrine's Comet made at the Royal Observatory, Greenwich, said that this comet had rather eluded observation in England, and the two observations made in the early morning of the 6th and 7th instant represented considerably more watching by the observers than might appear from the results. Mr. Crommelin had been on the watch for the comet for several mornings, but cloudy weather prevented observation. The comet had now gone south and is invisible in England at present, but there is a prospect of its being visible again shortly.

Mr. Crommelin. This comet will perhaps be visible in broad daylight in the southern hemisphere. In January it will be about as well placed in the evening sky as it was on November 6th in the morning sky, and I hope we shall then be able to get more observations of it.

The following papers were announced and partly read:—

W. F. Denning. "The Radiant-point of the October Meteors."

W. E. Cooke. "A Setting Apparatus for a Transit-circle."

R. T. A. Innes. "On the Proper Motion of Lacaille 4336."

W. T. Lynn. "On the Proper Motion of μ Cassiopeiæ."

Isaac Roberts. "Photograph of the Spiral Nebula M. 33 Trianguli."

E. J. Stone. "Note on some remarks of Mons. O. Callandreau in the 'Bulletin Astronomique' for Nov. 1895."

E. J. Stone. "Note on a Crayon Drawing of the Moon by John Russell, R.A., at the Radcliffe Observatory, Oxford."

Royal Observatory, Greenwich. "Observations of Comet *c* 1895 (Perrine), made with the Altazimuth."

A. M. W. Downing. "Note on Newcomb's Tables of the Sun."

The following gentlemen were elected Fellows of the Society:—

Major Kingsley Foster, Shenley, Redhill; *Rev. Henry A. Hall*, M.A., Grammar School, Totnes, Devon; *Richard Llewelyn Jones*, M.A., Professor of Physics, Presidency College, Madras; *Herbert Savery*, M.A., Marlborough College, Wilts.

The following Candidates were proposed for election as Fellows of the Society:—

Cyril E. Ashford, M.A., Assist. Master, Harrow School (proposed by W. H. M. Christie).

Frank Arthur Bellamy, Assistant, University Observatory, Oxford (proposed by H. H. Turner).

Thomas Folkes Claxton, First Assistant, Royal Alfred Observatory, Mauritius (proposed by W. H. M. Christie).

Philip H. Cowell, M.A., Fellow of Trinity College, Cambridge (proposed by W. H. M. Christie).

Robt. Fermor Rendell, B.A., The Glen, Blackheath Hill, S.E. (proposed by W. H. M. Christie).

George Albert Smith, St. Ann's Gardens, Brighton (proposed by J. H. Mitchiner).

Charles Albert Taylor, 33 Argyle Street, Argyle Square, London (proposed by A. Fowler).

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE sixth session of the Association was opened on Wednesday, the 27th November, at University College, Gower Street, the President, *Mr. E. W. Maunder*, occupying the Chair.

Seventeen new members were elected and the names of nine candidates for membership were read and suspended.

Mr. G. T. Davis read a short paper on "Coloured Star Observation." He remarked that when engaged in star-colour observation he had noticed that in the cases of a certain proportion of the stars it was almost impossible to fix the tints. He had attributed the difficulty to the short-focus object-glass of his telescope acting as a kind of prism, but he had found the same peculiarity in other refractors which he had had the opportunity of using. He suggested that possibly in the case of these stars the tints might be estimated with something like exactness by means of the "tintometer." He had come to the conclusion, from an examination of the report of the B. A. A. Coloured Star Section, that the spectra of stars had some relation to their colours.

The President remarked that he had not had much experience in this class of observation, but he believed that the colour and type of spectrum were in very close accord.

The Secretaries read two papers of instructions for the observation of Mercury and Venus, prepared by Mr. H. McEwen for the use of the New South Wales Branch.

Mr. A. C. D. Crommelin remarked that Mr. McEwen was not quite up to date on one point, namely, the specific gravity of Mercury: Mr. McEwen gave it as 7·5, but a recent determination obtained by Mr. Backlund from the perturbations of Encke's Comet gave only 3·5. Mr. Crommelin also called attention to the remarkably low albedo of the planet Mercury. While Venus had probably the highest albedo of any planet, Mercury had by far the lowest.

Mr. Holmes read a paper on "Drawings and Jovian Latitude," the object of which was to show the utter unreliability of drawings at present as evidence of the changes that took place in the latitude of the belts on Jupiter. He contrasted a number of drawings, pointing out the differences which existed, and urged that drawings not founded on micrometrical measures, or at least made for the purpose of giving the latitude of the various features, would have to be rigidly excluded in discussing the "possible periodicity of Jovian markings."

Mr. Lewis thought Mr. Holmes had only considered the bad drawings. Had he seen Prof. Hough's drawings made from micrometer measures?

Mr. R. W. Buttemer said he was trying the use of a ruled glass micrometer in the eyepiece, in conjunction with a scale corresponding to it on the cards for drawing the planet. He had tried drawing the belts beforehand, but that was obviously objectionable.

Mr. Lewis pointed out that while the differences mentioned by Mr. Holmes seemed large, this might be because they were dealing with small telescopes. The largest discordance was not more than 1½ second of arc.

Mr. Holmes pointed out that the changes in question were still smaller.

Mr. Lewis admitted that, but urged that the making of drawings should not be discouraged. It was not every one that possessed a micrometer.

Mr. Holmes said that nothing was further from his intention than to discourage drawings, but it would not do to use such drawings for purposes for which they were not intended.

Mr. N. E. Green said that the differences between the latitude of the belts which Mr. Holmes had called attention to were nothing as compared to the changes that had occurred on the planet during the last 40 years. It was most desirable that the members should be encouraged to make drawings, so that between them all they could substantiate any changes of a large character that might take place.

The President was very glad that Mr. Holmes had spoken a second time and had disclaimed any intention to disparage the drawings of the Jupiter Section, which he thought were a credit to the Association, but whether they lent themselves to measurement for absolute determination of latitude was quite a different thing. Probably if greater attention were drawn to the matter, greater accuracy would be secured, and he trusted that Mr. Holmes' paper would lead to that result.

Mr. Petrie read a note of Mr. G. K. Gilbert's pamphlet on the "Origin of Great Walled Plains," by the *Rev. J. H. Tuckfield.* The writer argued against the impact theory of moonlets, and submitted that their great size was adequately accounted for by volcanic eruption under the peculiar conditions prevailing on the Moon.

Mr. Schooling read a paper by *Mr. S. E. Peal* on "Problems in Selenology: what does 'Tidal Retardation' on the Moon imply?" Mr. Peal, after alluding to the change of opinion in recent years regarding the surface temperature of the Moon, remarked that this great discovery relieved them of the perpetual water problem, and opened the door to a new advance in Selenology. Further, the newly accepted views regarding tidal retardation as the means by which the speed of lunar rotation in past ages had been slowed down, rendered untenable the old idea of a solid tide, or "meniscus" giving an ellipsoidal figure, to account for the real libration. Yet the old veiw of a molten lava and volcanic surfacing so far held its ground that the possibility or probability of these tides being water-tides was not yet fully admitted. Mr. Peal contended that there was reliable evidence in several directions that these lunar tides were of water rather than molten lava.

The President said he thought that Mr. Peal's ideas were pretty well known to all present. For himself he was bound to say that, as far as his knowledge of the lunar surface went, he was disposed to believe in the lava-tide rather than the water-tide theory.

Some slides having reference to Helium were then thrown on the screen, as also were some star photographs by Dr. Sheldon and a mechanical slide designed by Mr. Schutz on the principle of the planisphere.

The Meeting then adjourned to Dec. 18.

ROYAL METEOROLOGICAL SOCIETY.

The monthly Meeting of this Society was held on Wednesday evening, Dec. 18th, at the Institution of Civil Engineers, Great George Street, Westminster, *Mr. R. Inwards, F.R.A.S.*, President in the Chair.

Mr. R. H. Scott, F.R.S., read a paper "On some of the differences between Fogs, as related to the Weather-systems which accompany them." In this it was shown that there are at least two distinct classes of phenomena described under the generic name of "fog." In the case of anticyclonic fogs no rainfall takes place, the temperature is low in the morning, and there is a considerable rise of temperature during the day; while in the case of cyclonic fogs, rainfall does take place, and the temperature is high in the morning, frequently approaching or even equalling the maximum for the day. Mr. Scott also investigated the cases of several well-marked fogs in London, and found that there was no direct relation traceable between the temperature accompanying them and the death-rate.

Major H. E. Rawson described the results of his analysis of the Greenwich Barometrical Observations from 1879 to 1890, with special reference to the declination of the Sun and Moon.

A paper by *Mr. S. C. Knott* was read, giving the results of his meteorological observations taken at Mojanga, Madagascar.

Mr. Scott also exhibited some specimens of the illustrations in the "International Cloud Atlas" which is now being prepared for publication.

The Sun's Path in Space.

Observations for ascertaining the Sun's apex, commenced by Sir Wm. Herschel a century ago, have been continued by successive astronomers, using groups of stars, differing in number, in brightness, and in proper motion. The results agree within about 30°, so that the apex of the Sun's path may, within this limit, be considered as fairly ascertained, though neither plane nor orbit of motion have hitherto been determined.

To the extent of about 30°, however, successive observations have shifted the apex to the N.E. nearly in the plane of the Milky Way. The cause of this difference between the results of the earlier and later observations deserves consideration. The subject is discussed in Proctor and Cowper Ranyard's 'Old and New Astronomy,' pp. 754–760, and a diagram given upon which the diagram annexed to this paper is founded.

The earlier observations are referred to an epoch a century earlier than that of the later computations, but this cannot account for the difference. An average relative motion of the stars of one second of arc in each year would only change the Sun's apex about 1″ per annum, or less than 2′ in the century. The different results from the observations are probably mainly due to the different average distances from the Sun of the stars upon which the observations were based.

Magnitude was at first used to measure the comparative distance of stars, but though the average brightness of the stars must diminish with distance, it is now known that stars differ so much in intrinsic brillianee, that this cannot be relied upon as a test of the comparative distance from us of individual stars.

The amount of proper motion is now deemed the best test of distance of a star. It is assumed that the stars of greatest proper motion are generally nearest to the Sun, and this is confirmed by many of such stars having yielded a measurable parallax. Professor Eastman gives the following table of 46 stars whose parallax has been ascertained, which shows that with these nearest stars the mean proper motion and mean parallax decrease together; while, singularly enough, their mean magnitude increases as the motion and parallax decrease:—

	No. of Stars.	Mean Magnitude.	Mean Proper Motion.	Mean Parallax.
1......	9	5·57	4″·93	0″·32
2......	9	5·59	2 ·33	0 ·20
3......	9	3·37	1 ·04	0 ·20
4......	9	2·36	0 ·38	0 ·16
5......	10	2·84	0 ·06	0 ·13

(Bull. Phil. Soc. Washington, vol. ii. pp. 143–172.)

The so-called proper motion of the stars is, however, actually their relative motion with respect to the motion of the Sun.

Mr. Stone concluded, from an analysis of the proper motions of 1167 stars, that on an average the solar motion constituted three-sevenths of the apparent motion. ('Monthly Notices,' xxvii. p. 389.)

Of the 261 stars of largest proper motion catalogued by Bossert ('Bulletin Astronomique,' 1890), about six-sevenths appear to move in opposition more or less to the Sun's path. The influence of the Sun's motion on the apparent motion of the stars is thus very great, and it is this influence which points out the Sun's path.

In the Table on p. 47 the results of some determinations of the position in space of the solar apex have been collected, which illustrate the connection between the position of the apex and the distance of the stars from which it is computed.

The results of these successive investigations appear to show that the Sun's apex, as deduced from more distant stars, moves N.E. along the plane of the Milky Way, compared with the apex deduced from nearer stars.

The three observations of Professor Boss are specially significant. Nos. I. and II. combined should give a mean result; but the deduction of the 26 nearest stars throws the apex still further to the N.E.

The shifting of the apex of the Sun's path along the edge of the Milky Way seems to point to a plane of motion of the Sun nearly coinciding with the plane of the Milky Way, or perhaps more nearly with the plane of that great circle of bright stars, first described by Sir Wm. Herschel as inclined about 20° to the galaxy and which passes through Lyra, in or near which constellation the solar apex lies.

Computer.	Date.	Resulting position of Apex.		Data used for the Discussion.
		R.A.	Dec.	
		° ′ ″	° ′ ″	
Sir W. Herschel.	1783	260 6	+26 3	14 stars, mostly large and of large P.M.
Argelander * ……	1837	255 54 8	+37 49 9	21 stars whose annual P.M. exceeded 1″.
	„	259 14 0	+39 13 8	50 stars whose annual P.M. was between 0″·5 and 1″.
	„	61 58 0	+29 13 8	319 stars whose annual P.M. was between 0″·1 and 0″·5.
Airy †…………..	1859	261 29	+24 44	113 stars of considerable P.M.
Dunkin …………	1863	263 43	+25	1167 stars whose average P.M. was probably less than that of the groups used in former determinations.
L. Struve ………	1887	273 21	+27 19	2509 stars of small average P.M.
Boss ……………	1890	280	+43	135 stars brighter than the 8th mag.
	„	286	+45	144 stars fainter „ „
	„	289	+51	The stars used in the two previous determinations were combined and used, omitting 26 stars which had greatest P.M., viz. between 0″·4 and 1″·0.
O. Stumpe………	1890	288	+42	551 stars with annual P.M. between 0″·16 and 0″·32.
		279	+40	340 stars with annual P.M. between 0″·32 and 0″·64.
		288	+32	105 stars with annual P.M. between 0″·64 and 1″·28.
		285	+30	58 stars with annual P.M. greater than 1″·28.

* Mémoires de St. Pétersbourg, 1837, tome iii. p. 588.
† Mem. Ast. Soc. xxviii. p. 143.

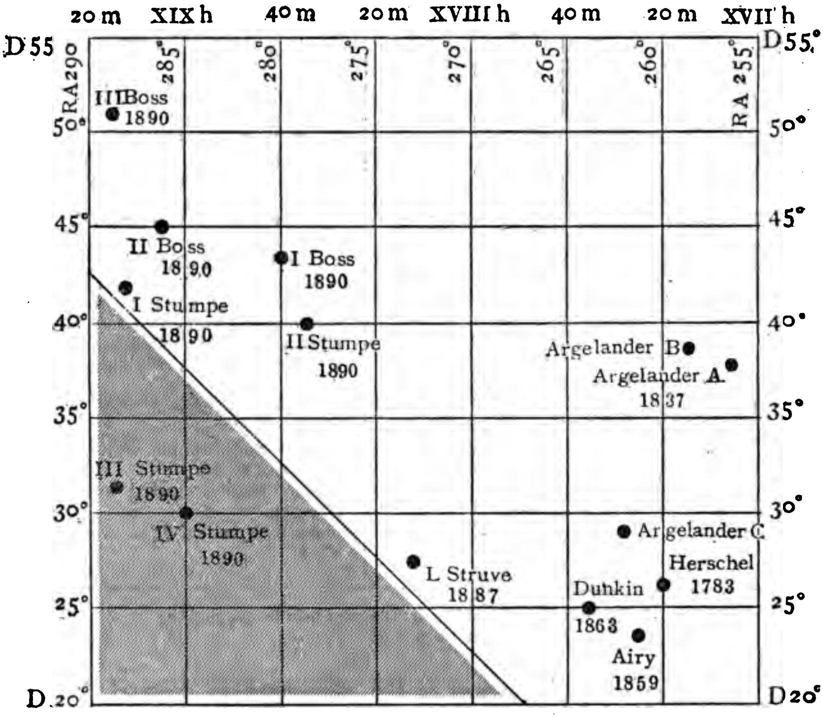
How may the difference in the solar apex as deduced from nearer and more distant stars be explained?

If the Sun's motion were rectilinear and the stars at rest, no difference would exist in the radiant-point of the nearer or more distant stars; but if, as the laws of gravitation lead us to assume, the Sun's path is in an elliptic or hyperbolic curve, the apex would be shifted in accordance with the varying direction of the tangent to curve, and this shifting would be in proportion to the apparent velocity.

The nearer stars have, as we have seen, the greatest apparent velocity, as the trees beside a moving train appear to move faster than do the distant hills. The apex deduced from the nearer stars is, as has also been shown, shifted to the S.W. along the northern edge of the Milky Way; this appears, therefore, to indicate the direction of the Sun's path.

It appears probable, therefore, that the Sun moves in a retrograde orbit, from E. to W., and in a plane inclined a few degrees to that of the Milky Way.

The probability that this is the Sun's true path may derive some confirmation from other observations of the proper motion of the stars.



The shaded area indicates roughly the Milky Way.

Mr. Gore writes:—"With reference to a possible motion of the stars in some general system, M. Rancken has found, from an examination of 106 stars, a tendency to drift along the course of the Milky Way, from Aquila towards Cygnus and Cassiopeia, and past Capella through Orion to Argo. The larger motions shown in Proctor's map of the proper motions exhibit this tendency in a marked degree between Cygnus and Capella, and less clearly on to Sirius, but the smaller motions not so well" ('Visible Universe,' p. 197).

This apparent drift of the stars from Aquila, near the Sun's apex, eastwards along the plane of the Milky Way, to the anti-apex and on to Argo, is just such as would be occasioned by a real motion of the Sun in that plane, in a contrary direction from E. to W.

The whole group of the Pleiades is likewise found to drift along from W. to E. nearly in the plane of the galaxy, a drift which may probably be due wholly or in part to the Sun's motion from E. to W.

The relation of the solar system to the galaxy would thus resemble that of Uranus and his moons to the ecliptic, the solar system being inclined about 70° to the plane of the galaxy and the planets revolving round the Sun in a reverse direction to the orbit attributed to the Sun.

It has been suggested ('Old and New Astronomy,' p. 804) that the change of apex might be due to a drift of the Milky Way, assuming the later observations to be founded chiefly on stars belonging to the Galaxy. But the observations are based on various groups of stars, yielding a different apex with increasing distance.

To attribute this to the motion of the stars, we must assume that the stars cross the Sun's path revolving from West to East with velocities decreasing in proportion to their distance. But of such a system the Sun would doubtless form part revolving with the stars round a common centre.

In such a system (which has often attracted speculation) the Sun would presumably have a shorter period of revolution than the encircling stars, which therefore would in their courses lag behind the Sun and appear to move in a contrary direction. An apparent drift of the stars from West to East, such as has been observed, would thus indicate a real motion of the Sun from East to West.

If the stars are found to have such a systematic motion, the position of the Sun's apex would be the result of the combined motions of the Sun and stars, just as meteor-radiants result from the combined movements of the Earth and meteors. The variations in the apex already observed appear, however, to show, whether with or without the hypothesis of a systematic motion of the stars, that the Sun moves in a retrograde orbit from East to West and in a plane inclined a few degrees to the plane of the Milky Way.

G. C. Bompas.

A Method of Investigating the Velocity of Stars in the Line of Sight with Small Instruments.

Photographs of the spectra of stars are in general obtained by two methods—by the use of an objective prism or of a slit spectroscope. The objective prism, which has been used with so much success by Prof. E. C. Pickering and Prof. Norman Lockyer, gives fine spectra with small aperture, the waste of light being reduced to a minimum, but it does not permit the comparison of the star-spectrum with that from a terrestrial source placed in juxtaposition. On the other hand, the slit spectroscope, which Messrs. Huggins and Vogel were the first to use, and with such excellent results, is less sensible to variations due to flexure, to temperature, or to atmospheric conditions, and, moreover, easily lends itself to the comparison, mentioned above, of terrestrial and celestial spectra, and thereby to the measurement of radial velocity. But for the best results the spectroscope requires to be mounted on a large telescope, which it is not within the power of all to command, and, besides, such telescopes are somewhat unhandy to use.

For *absolute* measures of radial velocities the slit spectroscope is a necessity, but the conditions are different when one only wants to find *relative* radial velocity or the variations of such velocity. However, in all previous observations on variation of velocity the process has been the same as for absolute measures. To compare the velocity of two stars or of the same star in two positions, a star-spectrum has been placed in juxtaposition with a terrestrial spectrum, and the *absolute* velocities have been measured in each case and the difference taken. But it would have been equally good to have compared first the two star-spectra, if it were possible to place them in juxtaposition, and then the two terrestrial spectra, this latter operation being necessary to determine the errors due to temperature and flexure. Starting from this idea, I have been led to suggest a mixed method that presents the chief advantages of the two already mentioned, which consists in combining in one apparatus the essential features both of the objective prism and of the slit spectroscope, but giving them the same prism and the same photographic camera. Each part is now used for the task of which it is best capable. The objective prism is used to photograph the stellar spectra; the slit spectroscope photographs adjacent to them the spectra from a terrestrial source.

The objective prism is, as usual, mounted on an equatorial telescope, with a guiding telescope attached. But to this is added a small totally reflecting prism placed opposite the centre of the outer side, and a collimator with an ordinary spectroscope slit placed on one side and perpendicular to the incident rays from the star. The collimator with the totally reflecting prism, the large objective prism, and the large spectroscope make up an ordinary slit spectroscope *.

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* The best method is for the guiding telescope to be directed towards the star itself, and for the edge of the objective prism to be parallel to the diurnal motion of the star. Moreover, the collimator, the totally reflecting prism, and the guiding telescope (which may have a short focus) must be rigidly attached one to the other. As for the large telescope, if it has considerable flexure, the following means should be adopted:—1. Fasten to the plate-carrier a totally reflecting prism which, with an auxiliary telescope, will allow the image of the red part of the terrestrial spectrum to be seen; 2. Have the plate-carrier so mounted as to be movable in the direction of the diurnal motion, or even

The observation with this apparatus is simple. The stellar spectrum is photographed in the usual way by help of the guiding telescope. During the exposure the terrestrial spectrum is photographed, not immediately adjacent to the stellar spectrum, but distant from it by a few millimetres, the two spectra being symmetrical with respect to the optic axis of the large telescope, and placed in such a way that the lines of equal refrangibility are in the same straight line. We then pass on to the star with which comparison is to be made, immediately after or, it may be, after a few days, and proceed as before, care being taken that, with the help of the guiding telescope, the stellar spectra may be adjacent, and, similarly, the terrestrial spectra must be placed next one another by the help of a small movable stop on the slit.

There may thus be placed in juxtaposition several stellar and terrestrial spectra. The difference of velocity of the two stars is given by the displacement between the stellar spectra minus that between the two terrestrial. This method is extremely precise, since all the lines of the series of spectra can contribute to the measure.

If it is required to find the absolute velocity recourse may be had to a star whose velocity is known, or the principle recently set forth by Herr A. Orbinsky (Ast. Nach., No. 3289) and Prof. Frost may be applied, which consisted in measuring the contraction or dilatation of the whole spectrum. But these authors presented their idea as being capable only of giving the relative velocity of stars photographed at the same time on the same plate. Now it is easy to see that the addition of the terrestrial spectra, which characterizes our method, permits us to find the absolute velocities themselves and, besides, the corrections due to temperature and flexure. It must be noticed, however, that the method of Herr Orbinsky requires intense spectra and long exposures, and gives, with equal dispersion, a displacement and precision half as small as the ordinary method *.

In summing up it may be said that the terrestrial spectra add to the objective prism the principal advantage of the slit spectroscope. They play almost the same part as the spectra which I have called "témoins" in a former paper on the subject ('Comptes Rendus,' 1894, vol. ii. p. 1282), which name may also be applied to these. It will be noticed that the coincidence of the stellar spectra will only be affected exactly when the guiding telescope

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movable in every direction in its own plane; 3. Before exposing the plate to the stellar spectra, place the terrestrial spectra in juxtaposition by help of the moving plate-carrier, and consequently the star-spectra will then be in juxtaposition. Another solution would be: Have the collimator parallel to the guiding telescope, give the same focal length to the great telescope, to the guiding telescope, and to the collimator, and attach these one to the other rigidly, so as to have the same flexures in the three parts.

* With Herr Obinsky's method the local displacements of the gelatine film are more troublesome, and it would be well to put the stellar and terrestrial spectra closer.

has followed both stars with equal accuracy. In order to verify the last point, I propose to attach to the guiding telescope a small photographic telescope provided with a reticule formed of two parallel bright wires, which will give a photographic image of the wires and the star moving between them during the exposure. This image will show the deviation of the star from its necessary position and give the means of correcting for this error.

In short, this method with the spectra "témoins" and the controlling image, added to the stellar spectra, supply all the data and corrections necessary for research in the field of determining velocities in the line of sight; and it has the advantage of being applicable to small-sized instruments, and its expense is but moderate. H. DESLANDRES.

Paris, 1895, Nov. 29.

Selenographical Notes.

THE DUSKY AREA ON THE EASTERN SIDE OF THE FLOOR OF ALPHONSUS.—Of the dark spots in the interior of this formation, that at the inner foot of the eastern rampart is the most prominent. Two others on the opposite side, of about the same size, are, however, nearly as easily traceable at certain phases, both in the telescope and on photographs, but smaller patches in other parts of the floor are far less obvious. As I have had many favourable opportunities during the last twelve years of examining these interesting objects, especially that under consideration, a very brief account of my scrutiny may be of interest to those who, like myself, are working with telescopes of moderate size, as showing what can be seen under these circumstances. The results of recent observations made by Prof. W. H. Pickering with the 13-in. Boyden telescope at Arequipa, add greatly to the interest of the investigation of this and other dusky spots in various parts of the Moon, though in a less favoured climate, and with inferior optical means, it may be hopeless to attempt to see the many minute and suggestive details which he has recorded.

One noteworthy fact with respect to the spot is that it is not traceable under a low angle of illumination. Examined under these conditions, say when the eastern wall of Alphonsus is not far removed from the morning terminator, the site is apparently not different in tone from the rest of the floor in its neighbourhood. At this phase, however, the following objects have been frequently noted,—a low ridge, which, under a higher sun, is seen to define in part the western limits of the patch, bending round to the foot of the eastern wall, which it joins at a place considerably to the south of the patch; a crater-rill, coming from the southwards, traversing the ridge, and extending nearly as far northwards as the site of the patch; a low mound within the area enclosed by the ridge, and near the northern end of the rill; a small triangular mountain close to the foot of the wall, a little north of the centre of the patch; and a small but distinct dusky crater, surrounded on the north and east by ill-defined shade, and standing just beyond the north-western edge of the site of the patch. These features may be traced for many hours after sunrise, and when the dusky area is conspicuously visible, thus enabling the observer to note their relative positions with respect to it. It then becomes evident that the curved ridge, scarcely traceable at the north-western side of the patch, gradually increases in height as it proceeds southwards, and forms a nearly semicircular enclosure (with the east wall of Alphonsus for diameter), which includes the dark area and another less dusky marking, of about the same size and shape, south of it. As the Sun's altitude increases these details gradually become difficult to make out, and when the morning terminator has advanced as far as 20° east of the formation, or thereabouts, not a trace of them can be detected, while the dusky area increases in definiteness and becomes obviously darker with less oblique illumination.

Prof. Pickering's drawing of the dark spots in Alphonsus ('Annals Harvard College Observatory,' vol. xxxii. part 1) is the result of the combination of several sketches. It shows this dusky area with less regular boundaries and less uniform in tone than it appeared to me, though always of a triangular shape, with edges more or less hazy and ill-defined. Upon it he noted two minute craters, each the centre of a dark region, with five still smaller, and an elevated crescent-shaped ridge, east of the more southerly of the larger craters. This appears to be nearly in the situation of the extreme northern end of the crater-row, which I have often seen under a rising Sun. A round white spot is shown exactly in the position where I see a dusky crater, viz. on the floor just outside the north-western boundary of the patch.

The confirmation of Prof. Pickering's assertion, that the tone of this and of other dark spots (like that of the floor of Plato) is independent of the Moon's phase, might be attempted with advantage by many in this country who cannot hope to descry his little craters, lakelets, and other minute details.

Beaumont House, Shakespeare Road,
Bedford, 1895, Dec. 19.

T. GWYN ELGER.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

On the Probable Errors in Declination of some Star Catalogues.

GENTLEMEN,—

In F. W. D.'s article in the 'Observatory' of this December there seem to be one or two errors for which Mr. Oertel's article in the Quarterly of the 'Astronomische Gesellschaft' is responsible.

Mr. Oertel gives the probable error of an observation of declination at Christiania as ±0″·54. This is incorrect, as one may see from the introduction to the Christiania volume of the great Catalogue. The method of computing the probable errors there set out gives that of the result; there are about three observations on the average, and this value is ±0″·54. On the other side of the comparison the Helsingfors value ±0″·51, for one observation, is not applicable, as the observations near 65° of declination were made mostly at Gotha, after the instrument had been mounted there. Why the probable error of one declination should in the mean be so much greater there, Prof. Krüger cannot with certainty explain. The cause suggested is that the beams of the observatory at Gotha had decayed and the floors touched the piers, so that frequent abrupt changes of zenith-point occurred. There was also a suspicion of wear at the centre of the declination arc, which was replaced by a complete circle after the zones were finished.

The probable error of one declination at Gotha was ±0″·76 in place of ±0″·51 at Helsingfors. Hence we may expect a probable difference of $\sqrt{(0''\cdot54)^2+\left(\frac{0\cdot76}{2}\right)^2}$, or ±0″·66 for one star in the overlapping zone between Christiania and Gotha—Helsingfors. This assumes two observations at Gotha and three at Christiania; and that the few cases of more than two at Gotha compensate for the cases in which two only were taken at Christiania, with a trifling allowance for unknown proper motion. Mr. F. W. D.'s mean error of ±0″·96 I take to be *average* error, meaning a probable difference ±0″·96 × ·845 or ±0″·81. The constant difference of −0″·47 is to be explained, I imagine, by referring to the use of verniers at Christiania.

In my own investigations I have usually given the zone observations of the 'Astronomische Gesellschaft' a weight equal to that of the same number at Greenwich, those cases excepted in which the probable error of one observation is more than ±0″·6 or ±0″·7. On this system Christiania receives half weight for two or three observations, Gotha seven-tenths for two observations, but Helsingfors weight unity for two or three. The accuracy of the Greenwich declinations has been gradually increasing for many years, when we judge by residual errors in complete discussions.

I find about 200 stars fully discussed in declination in my computation books of the last three years, that is, by bringing together all available observations since Bradley and Mayer, reducing to 1875·0, and calculating proper motions by least squares, after adjusting the weights as accurately as possible. Of these 130 are in zones of the 'Astronomische Gesellschaft,' which are published as catalogues or are otherwise at hand here; I did not send for manuscript results, as the declinations were wanted for immediate use. These discussions by least squares were not applied for Bradley's stars unless his observations were very scanty or some doubt arose. The 130 stars are in the zones observed at Christiania (70°–65°), Helsingfors—Gotha (65°–55°), Cambridge, Massachusetts (55°–50°), Bonn (50°–40°), Leyden (35°–30°), Berlin B. (25°–20°). The differences C—O in the form adopted by Argelander in vol. vii. of the Bonn Observations were extracted from the computing-books, and the sums of the 130 discrepancies were $+37''\cdot07$ and $-33''\cdot05$. The probable error for one star was therefore $\frac{70''\cdot12}{130}\times 0\cdot845 = \pm 0''\cdot46$, agreeing very nearly with the unit of weight (Auwers') which I had adopted.

The constant difference $\frac{+4''\cdot02}{130} = +0''\cdot031$ is less than its probable error $\pm 0''\cdot04 = \frac{0\cdot46}{\sqrt{130}}$, but is mainly due to one discrepancy of $2''\cdot6$, which I have inquired about, as the two observations agree pretty well only, and the best one disagrees the worst with other good catalogues.

The probable error of these stars of the A.G.C. which receive full weight seems to be about $\pm 0''\cdot41$; the remainder give about $\pm 0''\cdot6$, as we would expect. These probable errors are not much too small, as only a portion of the residuals C—O are taken from solutions in which the A.G.C. was employed; another portion are comparisons made after solution with a newly published catalogue. In all cases Auwers' reductions to the A.G.C. system was employed in the final comparisons.

Of the 200 stars 103 were determined at Greenwich by two to four observations (and no more) in some one or more of the three divisions—1872, 1880, and 1890, combining in the latter the yearly results up to 1892 inclusive. The sum of positive values (C—O) in these cases was $18''\cdot70$, that of negative ones $16''\cdot05$. This gives a constant difference $+0''\cdot026$, a probable error of one comparison of three Greenwich observations $\pm 0''\cdot295$. This number should, however, be increased about 10 per cent., as the Greenwich values were in almost all cases employed in the solutions, and were usually among the last data employed; so that, from these comparisons, I infer that the probable error of the mean of three Greenwich declinations is $+0''\cdot32$—in pretty close accordance with my previous results. The single zones of the A.G.C. would undoubtedly exhibit discrepancies in accuracy, depending on the instruments and care in using them; but the material which I have at hand to test this is not sufficiently abundant. Professor Becker, from actual comparisons with the Ten-Year Catalogue (allowing $6\frac{4}{10}$ observations on the average to the latter), finds $\pm 0''\cdot46$ for the *mean* error of $2\frac{7}{10}$ observations of his own, or $\pm 0''\cdot31$ for probable error. As he allows $\pm 0''\cdot24$ for constant mean error at Greenwich, we may regard the Berlin zone as equally accurate with the Greenwich observations. It represents, I suppose, the best existing Continental practice in meridian work of this character. The original plan of the zones required a probable error in declination for each observation of $\pm 0''.72$ or less; the one published case where this was not complied with (Christiania) is also the one where verniers were used, and Prof. Fearnley took pains to make more observations than two on about half his stars. Becker's probable error of the single observations in declination (in the zone 20°–25°) is about $\pm 0''.30$, but he admits the existence of additional constant errors. One may perhaps be pardoned for wishing that the methods invented by Repsold could be employed in illuminating the field and divisions of the Greenwich Transit Circle and the other great English instruments.

Yours faithfully,

Williamstown, Mass., TRUMAN HENRY SAFFORD.
1895, Dec. 19.

Eclipses and Chronology.

GENTLEMEN,—

I find myself unable to agree with the views expressed by Mr. Lynn, in the May number of the 'Observatory,' in regard to the eclipse of the Sun mentioned by Julius Capitolinus, viz. that the eclipse of A.D. 240 Aug. 5 was really the one that occurred early in the reign of Gordian III. It seems to me that this view of the subject cannot possibly be accepted without doing violence to all the narratives that have come down to us through the ages concerning it. For it must be remembered that the eclipse of A.D. 240 occurred early in the morning, about one hour after sunrise; and Julius Capitolinus says—"*This eclipse of the Sun was so great that people thought night was come, and nothing could be done without lights.*"

It is a little difficult to conceive how people could think that night was come so soon after sunrise; but the statement would be applicable to the eclipse of A.D. 237 April 12, which took place just before sunset. Moreover, Ricciolus gives the date of the eclipse as A.D. 237 April 12, and also states that it took place about the time of the sixth persecution of the Christians (A.D. 236), *and when the young Gordian was proclaimed emperor.* This would at least certainly imply that it took place during the first year of his reign.

Struyk says the eclipse was total at Bologna, which is certainly correct; whereas the line of totality in the eclipse of A.D. 240 passed ten degrees to the southward of that place. Besides, Struyk's statement that there was a similar eclipse two years later would certainly be incorrect if it referred to the eclipse of A.D. 240, for no similar eclipse occurred in that part of the world during the following twenty-five years. But if he referred to the eclipse of A.D. 237, there was a small partial eclipse two years later and a *similar* eclipse three years later.

I am surprised that Mr. Lynn should infer that Boetticher agrees with me less perfectly than I claim in regard to the dates of celebration of the Olympic games. I only claim that they were celebrated in the bissextile or leap years; and the dates which he gives, A.D. 252 and 268, were certainly leap years. Boetticher's mistake consisted in giving the number of complete Olympiads instead of the number of the festival, a mistake which is often made by writers on chronology. The statement made by Boetticher that the last Olympic festival took place in the year A.D. 395, to which Mr. Lynn refers, is certainly erroneous; for no one places the death of Theodosius the Great later than January, A.D. 395; and if they were celebrated in July of that year they must have been celebrated after they were interdicted by Theodosius.

At Mr. Lynn's suggestion I have computed the eclipse of the Sun which occurred A.D. 402, Nov. 11. If that was really the eighth year of the reigns of Arcadius and Honorius, it would follow that Theodosius died in January, A.D. 395; but we have direct and independent evidence that he died in January of A.D. 394. For it is well known that Theodosius the Great survived the battle and victory over Eugenius only till the following January, during which period the Roman world was again for a brief moment under the control of a single emperor. The date of that great battle therefore determines the date of the death of Theodosius and the beginnings of the reigns of Arcadius and Honorius.

According to the historian Zosimus a great eclipse of the Sun occurred during the progress of that battle, which he describes as follows:—"*On the very occasion of the battle an eclipse of the Sun occurred, such an eclipse that for a long time it was thought rather to be night.*" The date of that eclipse must have been A.D. 393, Nov. 20, since that was the only eclipse which was visible in that part of the world during the latter part of the reign of Theodosius. I find that that eclipse occurred about the middle of the day, and was total both at Rome and Constantinople. The shadow was more than 100 miles in breadth, and the eclipse must have been very nearly total at the place where the battle was fought. This would give January, A.D. 394, as the date of the death of Theodosius; and since Alaric invaded the Peloponnesus in the autumn of the same year, it follows that that invasion took place in the year A.D. 394. Now, according to Boetticher, as quoted by Mr. Lynn, the last celebration of the Olympic games took place two years before that invasion; they therefore took place in the year A.D. 392, which was a leap year, thus agreeing with the other dates given by Boetticher for the celebration of those festivals, and also with all those which I have determined by means of eclipses.

Faithfully yours,

Cleveland, Ohio, 1895, Dec. 10. JOHN N. STOCKWELL.

Comets due in 1896.

GENTLEMEN,—

Faye's periodical comet must, according to rule, be reckoned at the present appearance amongst the comets of 1896, because it is not due in perihelion until the 19th of March in that year. But it was nearest the Earth in October, and was sighted by M. Javelle at Nice on the 26th of September; as at its first predicted return in 1850–1, the period of visibility was over long before the time of perihelion passage.

The only periodical comet, then, which is expected to reappear during the course of 1896 is that which was discovered by Mr. Brooks on the 6th of July, 1889, and calculated to have a period of somewhat less than seven years. Much interest was imparted to this comet by the suggestion thrown out by Mr. S. C. Chandler that it was identical with the long-lost comet of Lexell, discovered by Messier on the 14th of June, 1770, and repeatedly disturbed in its motions by Jupiter, and so powerfully as completely to change its orbit. The subsequent investigation, however, of Dr. C. Lane Poor did not confirm this view; and since then M. Schulhof has put forward another candidate for identity with Lexell's comet, as he finds it probable that this applies to the comet discovered by Prof. Swift on the 20th of August last. The period calculated for this comet is about 7·2 years; but its position will not be favourable at the next return in 1902, and M. Schulhof thinks it likely that it may not be seen again until 1931, so that we shall probably (those of us who survive until the last-named date) have long to wait for the proof or disproof of his theory. Meanwhile it is to be hoped that Brooks's comet of 1889 will come into view again in 1896, and perhaps this may throw some further light upon the question. Yours faithfully,

Blackheath, 1895, Dec. 2. W. T. LYNN.

OBSERVATORIES.

[Continued from vol. xviii. p. 438.]

GÖTTINGEN. *W. Schur.*—The number of nights on which the heliometer could be used was very small, and even the work with the transit-circle suffered because of bad images. Herr Schur made heliometer observations for triangulation of the principal stars in the clusters *h* and χ Persei, for determinations of the diameter of the Sun and Jupiter, and for positions of Comet Gale. The Sun's diameter was also measured on 7 days with the 3-inch heliometer. Dr. Ambronn, with the great heliometer, made observations for triangulation of stars near the Pole and also measured some wide pairs of the Poulkova catalogue. Dr. Ambronn also worked on the triangulation of the Pleiades. Dr. Grossmann, with the meridian-circle, made direct and reflexion observations of Polaris, 31 zenith-distances of γ Draconis, and 25 of Mösting A.

KALOCSA. *T. Fényi.*—The work here has been chiefly solar. The prominences were examined on 196 days, the whole limb of the Sun being observed on 163 days of these. On Dec. 24, 10^h–12^h, G.M.T., a prominence of 11′ 1″ in altitude was observed enormously in excess of any other, as the next largest was only 4′ 27″; altogether 72 were observed of altitude above 100″. Besides these, 296 complete drawings of the Sun's disc, showing the spots and faculæ, were made.

KARLSRUHE. *W. Valentiner.*—Zone observations. With the 6-inch refractor comets 1894 I. (Denning), 1894 II. (Gale), and a few small planets were observed. The Bamberg Transit was used for latitude determination.

KIEL. *A. Krueger.*—Meridian observations in zone +55° to +65°. Observations of small planets and of comets. Researches on orbits of comets 1843 I., 1880 I., and 1882 II.

KÖNIGSBERG. *T. Franz.*—The observatory suffered by the death of the Director, C. F. W. Peters, who died 1894 Dec. 2. The 6-inch Fraunhofer heliometer was used for observations of the crater Mösting A, comets 1894 I., 1894 II., variable star 2 Herculis, and Struve's widely separated double stars in zone +15° to +30°. The meridian-circle was used for zone observations (+83°, 84°).

LEIPZIG. *H. Bruns.*—The parallax measures were concluded in the spring. Dr. Cohn made a series of latitude observations with the universal instrument. Zone observations. Time service. Meteorology.

MILAN. *G. Schiaparelli.*—Observations of 441 difficult double stars. Studies of surface of Mars, figures of Satellites of Jupiter. Satellite I. showed sensible elongation in direction parallel to the general trend of the belts; Satellites II., III., IV. showed no perceptible deviation from a circular disc. M. Celoria made numerous transit observations. Geodetic work. Magnetic and Meteorological work.

MUNICH. *H. Seeliger.*—Discussion of a long series of observations for refraction. A new working catalogue for the transit circle has been made, to form a catalogue of stars for geodetic work. 1200 places on 51 evenings were obtained. The 10½-inch refractor was used but little. Meteorology.

POTSDAM. *H. C. Vogel.*—The observatory has suffered by the death of Dr. Spörer, whose place has been filled by Dr. Scheiner, well known for his spectroscopic work. The work on planetary spectra has been continued. Dr. Lohse has made measures of diameters and also a number of drawings of Jupiter. He also made observations of Saturn for the purpose of determining its rotation-period. On 41 days from July 5 to November 15 he made studies of Mars. Photometric work for a photometric Durchmusterung of the northern sky. Photographs of the Sun have been taken regularly. In the astrophotographic department 380 plates have been taken, of which 46 have been measured, the aggregate number of stars being 11,750, so that, on an average, there are 255 stars down to the 11th mag. on each plate. The stars are, however, far from being uniformly distributed; for instance, on Plate No. 75 (R.A. $11^h\ 6^m$, Dec. +32°)—taken in good weather—there are only 37 stars, while on Plate No. 454 (R.A. $19^h\ 57^m$, Dec. +35°) there are 1312 stars. Work on parallax of stars and nebulæ has also been undertaken.

PRAGUE. *A. Safarik.*—In 1893 on 101 days 1200 estimates of brightness of 118 stars were made; in 1894 on 71 days there were 676 estimations of 93 stars. In all since 1880 the work of this observatory includes 22,000 estimations of magnitude of 150 stars.

STRASBURG. *E. Becker.*—With the large refractor Dr. Kobold made numerous observations of nebulæ, and some of comets Brooks 1893 IV., Denning 1895 I., Gale 1895 II., Encke, and Swift. The meridian circle was used on 199 days and about 3000 observations of stars were made in each element, and 200 of the Sun and major planets. The altazimuth was employed in determining variation of latitude on 46 evenings (386 pairs of stars), and for researches on the aberration constant.

TURIN. *F. Porro.*—Observations of variable stars. Meteorology.

VIENNA. (*M. Edler v. Kuffner.*) *L. de Ball.*—In 1894, 4229 observations of zone stars and 400 of fundamental stars were made, which brings up the totals to 15023 zone observations and 1478 fundamental. These observations are in a forward state of reduction.

ZÜRICH. *A. Wolfer.*—The observations of Sun-spots have been continued on the lines laid down by Prof. Wolf. From the table it appears that on no day was the Sun free from spots in 1894. The table of relative numbers being:—

January, Feb., March ..	rel. no.	72	71	observing	days.
April, May, June	„	95	80	„	„
July, Aug., Sept.	„	83	80	„	„
Oct., Nov., Dec.	„	63	64	„	„
For the year	„	78·1	29·5	„	„
For 1893	„	84·9	29·7	„	„

Observations were also made of Jupiter's disc. Time Service.

NOTES.

COMET NOTES.—Prof. Kreutz gives in Ast. Nach. (3320) revised elements of the great comet 1843 I. as follows:—

$$\begin{array}{rll}
T & = 1843,\ \text{Feb. } 27{\cdot}4482 \pm {\cdot}0012 \text{ Berlin M.T.} & \\
\omega & = 82^\circ\ 38'\ 2'' \pm 216'' & \multirow{3}{*}{$\left.\begin{array}{l}\\ \\ \\ \end{array}\right\}\ 1843{\cdot}0$} \\
\Omega & = 1\ \ 19\ \ 51\ \pm 265 & \\
i & = 144\ \ 20\ \ \ 4\ \pm\ \ 33 & \\
\log q & = 7{\cdot}74251 \quad \pm 0{\cdot}00127 & \\
e & = 0{\cdot}999914 \quad \pm 0{\cdot}000008 & \\
a & = 64{\cdot}0 \qquad\quad \pm 5{\cdot}9 & \\
\text{Period} & = 512^y \pm 71^y. &
\end{array}$$

The observations do not appear to admit a period of 36 years or 175 years, *i. e.* the hypothesis of identity with the Comet 1880 I. or that of 1668 must be rejected. A parabolic orbit appears likewise to be inadmissible. But a period of 800 years (the same as that of the great Comet 1882 II.) is quite consistent with the observations, and these two comets may originally have formed one body. If so, the relative position of their orbits indicates that the rupture took place at perihelion passage; such a rupture would not be surprising, considering the very close approach of these comets to the Sun.

The following is an approximate ephemeris of Faye's Comet. The brightness is now about 0·8 of that in September last:—

	R.A.	S. Dec.
	h m s	° ′
Jan. 1	22 57 27	3 16
5	23 5 55	2 45
9	23 14 19	2 12
Jan. 13....	23 22 59	1 46
17....	23 31 55	1 9
21....	23 40 53	0 33

The following are the latest elements of Perrine's Comet *c* 1895 and Brooks' Comet *d* 1895. They are by Prof. Kreutz (Astr. Nach. 3320, observations Nov. 18, 25, 29) and Dr. Halm ('Edinburgh Circular,' observations Nov. 29, Dec. 7, 13) respectively:—

	Perrine's Comet.	Brooks' Comet.
T=	1895 Dec. 18·33 G.M.T.	1895 Oct. 21·08 G.M.T.
ω	272° 40′	298° 53′
☊	320 29	83 5
i	141 38	76 16
log *q*	9·2831	9·9265

The following ephemerides (for Greenwich midnight) are deduced from these elements:—

	Perrine's Comet.		Brooks' Comet.	
	R.A.	S. Dec.	R.A.	N. Dec.
	h m s	° ′	h m s	° ′
Jan. 4....	19 25 36	16 25	2 25 8	66 52
9....	19 29 16	13 56	2 9 40	65 52
14....	19 32 20	11 50	2 2 0	64 57
19....	19 35 4	10 0	1 58 16	64 18
24....	19 37 20	8 16	1 57 56	63 46
29....	19 39 20	6 41	2 0 4	63 25

The brightness of Perrine's Comet is 2·58, 0·38 on Jan. 4 and 29 respectively; that of Brooks' Comet 0·10 and 0·03 on the same days. In each case that at discovery is taken as unity.

Perrine's Comet was well observed in Europe up to December 7, the latest observation to hand being a Greenwich one on that day; the comet was then very brilliant with a conspicuous tail. It was anticipated that it would be visible in the daytime in the southern hemisphere, and an ephemeris was telegraphed to the principal southern observatories, but no observations are yet to hand. It should be visible here in the evening early in January, and in the morning at the end of the month, rising some two hours before the Sun on Jan. 29.

Brooks' Comet was also well observed in Europe up to Dec. 15, the latest observation to hand being a Greenwich one on that day. It was in all cases a difficult object to observe, being large, diffused, and faint, without any definite condensation. It was only some 20 millions of miles from the Earth at the beginning of December.

Its orbit presents a striking resemblance to that of the bright comet of 1652; the following are the elements of this comet as computed by Dr. Halley from observations extending over 19 days, and reduced to the equinox of 1895:—

$$\begin{array}{rl} T = & 1652 \text{ Nov. } 13. \\ \omega = & 300^{\circ}\ 10'\cdot6 \\ \Omega = & 91\ \ 33\cdot0 \\ i = & 79\ \ 27\cdot7 \\ \log q = & 9\cdot928 \end{array}$$

It appears probable that the two comets are either identical or had a common origin. The high inclination to the ecliptic both of the orbit and of the axis, and the fact that no close approach is made to the orbits of any of the planets (the nearest approach is to the Earth's orbit, the distance being some 10 millions of miles), render periodicity not very probable.

M. Wellmann has an article on the orbits of comets in the 'Bulletin Astronomique' for December. He commences by pointing out that sensibly parabolic orbits occur far more frequently than the laws of probability would lead us to expect, and suggests that the repulsive electrical force of the Sun, which he supposes to be the cause of comets' tails, may sufficiently neutralize the attractive force as to convert originally elliptic orbits into parabolas. He, however, offers no explanation of the fact tha strongly-marked hyperbolic orbits are unknown, contrary to what the laws of probability would lead us to expect.

The 'Times' correspondent at Cape Town telegraphs under date Dec. 25:—"A comet has been visible during the last few evenings, which Dr. Gill says is the comet discovered by Mr. Perrine on Nov. 17. It is moving northward and less rapidly eastward, and is diminishing in brilliance nightly." A. C. D. C.

Minor Planet Notes.—'The Bulletin Astronomique' for December contains a somewhat technical paper by M. Tisserand on the perturbations of the minor planets by Jupiter. He examines especially the case where the period is approximately half that of Jupiter, and shows that this case is not necessarily unstable, but that oscillation of the period through a value equal to half that of Jupiter may take place.

Prof. Wolf gives an interesting account, in Ast. Nach. 3319, of his photographic method of searching for minor planets. He uses a portrait-lens, aperture 6 inches, focal length 30 inches, with field of view of 70 square degrees. The exposures range up to two hours, and two exposures of each region are given on the same night to distinguish genuine planetary trails from accidental marks. The plates are compared either (1) by simple superposition—a bad method, since the films are not in contact; (2) by printing a glass positive of one, and superposing, film to film; (3) by using a stereoscope, which throws planets into relief in consequence of their altered positions. A list of position of 32 planets from the photographs is given; these are not, however, considered so accurate as visual observations. 70° is found to be the practical limit of zenith-distance for planetary photography; little, therefore, can be done in the summer. An interesting comparison is given of various developers tried, and of their suitability in different circumstances.

In 1892 the ratio of new planets to known ones on the plates was 1 to 2·1; in 1893, 1 to 3·0; in 1894, 1 to 2·5; in 1895, 1 to 6·3. These figures suggest that the zone may be approaching exhaustion, at least as regards planets brighter than the 13th magnitude. Prof. Wolf remarks that he has never seen telescopically any of the planets discovered by him.

A new planet CE was discovered by Charlois on Dec. 9, and two others, CF, CG, by Wolf on Dec. 11. CF may be identical with (352), discovered by Wolf 1893, Jan. 12.

CC, discovered by Wolf on Oct. 13, has been numbered 407.

A. C. D. C.

THE RADIANT HEAT FROM THE MOON DURING AN ECLIPSE.—Scarcely ever can anyone have so fitly earned the epithet "patient," so often applied to the astronomer, as the Earl of Rosse, who for some years past has been engaged on an investigation which can only be pursued during lunar eclipses. His Lordship presented the results of this investigation at a lecture before the Royal Institution on May 31st last.

Some twenty-two years ago Lord Rosse made a study of the variation of the heat radiated from the Moon in relation to its change of phase, and the fact was observed that the effect of the heat received by the Earth from the Moon was not at a maximum at an interval after Full-Moon, as might have been expected, judging from solar analogies, but the maximum, as observed, occurred rather before Full-Moon, a result of which it is difficult to see the cause. Moreover, the variation during the phase showed that the radiated heat was derived directly from the Sun, not reflected by the lunar surface, but absorbed and afterwards emitted. The fact that the maximum did not occur after Full-Moon tends to show that this emission follows the absorption almost immediately, but Lord Rosse was induced to suppose that with the "far more rapid changes of illumination during an eclipse, the delay in the emission might be easily perceived." Hence the present research.

At the eclipses of May and November 1872, and August 1877, the state of the sky prevented observations of any importance, but on the occasion of the total lunar eclipse of 1884, Oct. 4th, Dr. Bœddicker (Lord Rosse was in America at this time) was more successful. It was found that the observed heat varied pretty nearly as the light (calculated), a slight lag being apparent in the heat, but, what was more remarkable, the heat rapidly increased after the end of the total phase, not towards the usual Full-Moon value, but to a limit only 87 per cent. of that value, and there seemed no disposition to return to Full-Moon value for quite half an hour after last contact with the penumbra. On the occasion of the total eclipse of 1888, June 28, the same fact was observed. At the time of last contact with the penumbra, the heat was 80·6 only, and $1^h\ 40^m$ later 81 per cent. only of its full value. At this eclipse, the circumstances of which were particularly favourable, the radiation appeared to diminish immediately the observations were begun an hour before first contact with penumbra, and during totality the heat received from the Moon was less than 1 per cent. of its Full-Moon value, but, as we have said, did not rise with equal rapidity after the eclipse. Lord Rosse confesses himself unable to give an explanation of the phenomenon.

The printed report of the lecture from which we have extracted these interesting facts, gives diagrams exhibiting the results, and also illustrations of the instruments employed (a thermopile mounted on the 6-foot reflector), together with a discussion by Lord Rosse of similar researches by Langley and others.

VARIABLE STARS.—The second Harvard College Circular states that in many cases, from examination of photographs of star-clusters, it has been found that stars in these clusters are variable. The photographs referred to are those taken at Arequipa with the Boyden Telescope, which is under the charge of Prof. Bailey. In the cluster in Canes Venatici (Messier 3) (N.G.C. 5272), 87 stars are said to be variable; in the cluster Messier 5 (N.G.C. 5904), 46 stars; in N.G.C. 7089, 2 stars; and 3 in N.G.C. 7099; but, on the other hand, in five other clusters no variables could be found.

This variability is said to be deduced from the examination of many plates, and Mr. Bailey's opinion is confirmed by Prof. E. C. Pickering and Mrs. Fleming. It appears that the periods of some of these variables are not of more than a few hours. As an instance of this, the results of five photographs of one star (in N.G.C. 5904), taken at intervals of one hour, are quoted in the circular: the deduced magnitudes are 14·3, 13·5, 13·8, 13·9, and 14·3. We are disposed to think that the photography must be *very* precise and the measuring very trustworthy before we ascribe this absolutely to variability of the star, although, as will be seen from the following note, the shortness of its period is not unique.

A remarkable Variable Star.—Dr. Chandler announces (Ast. Journ. No. 358) that the star 8598 U Pegasi varies from magnitude 8·9 to 9·7 in the remarkably short period of $5^h\ 31^m\cdot 15$. It is not of the Algol type, as the variation is continuous throughout the period, nor is it of the class to which η Aquilæ and δ Cephei belong, as its light curve is symmetrical, showing equal times of increase and decrease. These conclusions have not been hurriedly arrived at, for Dr. Chandler and Mr. Yendell have had this star under observation for more than a year, and consider, only after rejecting other hypotheses, that this is the true explanation of the various observations they have made. In the succeeding number of the 'Astronomical Journal' (359) Mr. Yendell gives his latest observations—minimum Nov. $3^d\ 6^h\ 56^m$, maximum Nov. 3 $9^h\ 27^m$, Dorchester (U.S.) Mean Time; and the period $5^h\ 34^m$ deduced from these. The place of U Pegasi for 1900·0 is R.A. $23^h\ 52^m\ 53^s$, Dec. $+15^\circ\ 23'\cdot 9$.

The Cause of Variation of Star-magnitude.—As is indicated in the preceding note, it is probable that all stars which are observed to vary are not affected by similar causes. There is a large class of stars, of which Algol is the type, whose variation it may almost certainly be said is caused by the revolution around it of a dark body, which at intervals partially eclipses it, so that during only part of the period does the variation occur, but during the other part the magnitude of the star remains constant. δ Cephei is another star which may be taken as the type of a class, the stars forming which are always varying in magnitude, but the time from maximum to minimum is not equal to that from minimum to maximum, which times are, in the case of δ Cephei, respectively $3^d\ 18^h$ and $1^d\ 15^h$. The phenomena attending this star have been well investigated by M. Belopolsky, who is of opinion that the variation is not caused by eclipse, although the star probably forms a close binary system with a dark component. A theory to account for such variation is set forth by Mr. Alex. W. Roberts in the November number of the 'Astrophysical Journal,' who thinks that there is an actual change in the temperature of the star as its companion passes from periastron to apastron, caused by the nearness of the bodies. The observed maximum and minimum do not occur until the stars have passed periastron and apastron of M. Belopolsky's orbit, and Mr. Roberts points out with considerable plausibility that this is quite consistent with his theory, referring to the analogy of the well-known facts of daily temperature. This explanation, as the author says, is certainly consistent with the principal observed features: (1) the rapid rise to maximum; (2) continuous variation; (3) narrow limits of variation, although, as might have been expected, it will not meet all the facts of every case. But Mr. Roberts candidly points out a crucial test, by which it seems he is prepared to let his theory stand or fall. The components of the binary star α Centauri are, at periastron, only one-third of the distance apart that they are at apastron, and the heat which the less luminous body receives in the former position is ten times greater than that which it receives in the latter. Photographs of this pair were taken at the Cape in 1875, and if Mr. Roberts's view that the eccentricity of the orbit causes variation of the light of a close binary be true, similar photographs taken in the year 1915 should show a considerable change in the relative magnitude of the photographic discs of the two components. Perhaps if a photograph were taken now the effect might show.

In a recent number of the 'Astronomical Journal' (No. 356) Prof. Newcomb publishes as a value of the solar parallax $8''\cdot773$, derived from the value of the parallactic inequality of Delaunay's lunar theory. In previous investigations of this kind Prof. Newcomb had for certain reasons, which he gives, preferred to use Hansen's value of this inequality, but since recent researches by Mr. G. W. Hill and Prof. Brown confirm Delaunay's value, Prof. Newcomb has been led to publish this deduced value of the solar parallax, which, however, as might be expected, he does not regard as final.

Mr. W. E. Cooke, M.A., has been appointed, by the Government of Western Australia, Director of the Colonial Observatory which is to be established at Perth, West Australia. Mr. Cooke is colonial born, and was educated at Adelaide University, where he took the degree of Bachelor of Arts in 1882. He then entered the Adelaide Observatary as Assistant to Sir Charles Todd, to whom he has been of much service. Several papers which Mr. Cooke has recently communicated to the Royal Astronomical Society attest his genius as a practical astronomer.

Obituary.—We regret to have to announce the death of John Russell Hind, LL.D., F.R.S., which took place on Monday Dec. 23rd last. Dr. Hind was born at Nottingham in 1822, and when quite a young man joined the staff of the Royal Observatory, Greenwich, being attached to the then recently established Magnetic and Meteorological branch. Though his work therefore was not actually astronomical, it is remembered by his colleagues that he devoted much of his own time to using the Sheepshanks Equatoreal, in the hope of being fortunate enough to find a comet. He took part in the first chronometric determination of the longitude of Valentia. From Greenwich Mr. Hind went to help Mr. Bishop in his observatory in Regent's Park, where he joined in the search for small planets, then being pursued with some activity, and discovered Iris and Flora and others. For these discoveries he received a pecuniary reward from the Government, and obtained such reputation that on the death of Lieut. Stratford in 1853 he was appointed to succeed that officer as Superintendent of the Nautical Almanac Office; the late Prof. J. C. Adams being also a candidate for the post. He still, however, retained the general superintendence of Mr. Bishop's Observatory, his assistants being successively Pogson, Vogel, Marth, and Talmage; and when the observatory was removed to Twickenham, in 1861, Mr. Hind went to live in the neighbourhood, and still remained in charge for some years. Dr. Hind will be remembered both as an observer and an author. He went to Norway to observe the total eclipse of 1851, July 28, and was thus one of the early observers of solar prominences; a remarkable observation of distortion of Biela's comet is recorded as made by him; and a variable nebula, which has lately aroused some interest, bears his name. He began his career as an author early, for at the age of 16, before he went to Greenwich, he contributed astronomical notes to a local newspaper, and about the same time published the 'Atmospheric Almanac,' in which he attempted to predict the weather throughout the year. Two years of this were published. But he has done more valuable work than this: his treatise on comets is well known, and until quite recently it was Dr. Hind's practice to furnish orbits and ephemerides of the comets as they occasionally appeared. Dr. Hind resigned the Superintendence of the Nautical Almanac Office at the end of 1891, after 40 years' service. He joined the Royal Astronomical Society on 1844, Dec. 13, and was made President in February 1880.

Notwithstanding the copious rainfalls of November and December, the total for the year 1895 is considerably below the average. The total rain registered at Greenwich during the year measured 19·69 inches, which is 4·85 inches below the fifty-year average (1841–90). The weather during Christmas was particularly unseasonable, rather more than an inch of rain being registered between Dec. 24 and 30, both dates inclusive.

The comparative scarcity of cloud during the year may also be judged from the fact that the number of observations made with the Transit-Circle at Greenwich is considerably in excess of that for any other year. We are informed that the number of transits is over 12,000.

Harvard College Circular, No. 3, announces that the star B.D. $+17^{\circ}\cdot4367$, R.A. $20^{h}\ 33^{m}\cdot1$, Dec. $+17^{\circ}\ 56'$ (1900·0), appears to be a variable of the Algol type. The change of brightness is said to be rapid, and the range of variation to be large, exceeding two magnitudes.

The Valz Prize of the Academy of Sciences, Paris, has been awarded to Mr. Denning, of Bristol, for his observations of shooting-stars, discoveries of comets, and other astronomical work. We offer our best congratulations to our esteemed contributor.

Mr. T. F. Claxton, who for some years has been attached to the Magnetic and Meteorological branch of the Royal Observatory, Greenwich, has been appointed First Assistant at the Royal Alfred Observatory, Mauritius.

Mr. Charles Martin, also of Greenwich, has recently been appointed Assistant to Dr. Rambaut at Dunsink.

From an Oxford Note-Book.

It is to be regretted that the average reporter is so little able to give the substance of a speech on scientific matters. When trying to cope with a scientific gathering, he almost invariably gives a full report of the introductory and formal speeches, especially if these are delivered by men of political eminence; and the real essence of the meeting is lost. When the Memorial to Adams in Westminster Abbey was unveiled, the Duke of Devonshire opened the proceedings in a few well-chosen but purely formal sentences—reported at full length in the *Times*; while to really important speeches about Adams's work, by such men as Lord Kelvin, Sir George Stokes, and several others, only a line or two was devoted. At the Royal Society Annual Dinner on November 30, two rather dull speeches by Mr. Ritchie and Mr. Shaw Lefevre were given similar prominence, while others of considerable interest were omitted altogether. For instance, not the least important toast at these annual gatherings is that of the Medallists for the year; and Prof. Ewing made an excellent speech in reply, not a word of which was given in the *Times*.

Prof. Ewing took a natural and national pride in the fact that three medals had gone to Scotland: he rallied Dr. Murray on having had the world for an oyster and been equal to the opening of it; and said of him and of Professor Ramsay, "Ye are both *Argonauts*, who have returned invested with a golden fleece." He further compared the finding of Argon with Sherlock Holmes's search for a document which had been concealed by the simple expedient of putting it in the most conspicuous place possible; and dubbed the discoverers Argus-eyed. He mentioned the generous practice of the Royal Society in giving not only a gold but a silver medal to each medallist, and inferred that whatever it might be in theory, the Society was in practice bimetallist—intending that one metal should go into circulation while the other was kept in reserve; and he finally reminded the new President, Sir Joseph Lister, of the occasion many years ago when at the Royal Society of Edinburgh he produced a number of flasks of milk which had been taken from the parent cow some months before under antiseptic conditions; and of the sensation in his audience when he (the President) showed his faith in this new treatment by removing one of the stoppers and drinking the milk. Even this cold-blooded statement of the points of an excellent speech may be of interest, and I give it here for what it is worth. But I wish we had had a verbatim report.

From the report of the meeting of the R.A.S. on December 13, given elsewhere, it will be seen that some progress has been made towards the actual use of the cœlostat. There is, of course, a good deal of difference between theory and practice in the case of a new instrument, and until some actual results have been obtained it would be a mistake to think that all the difficulties can be overcome in so simple a manner as theory would indicate. In his report on the Eclipse of 1893 (page 2), Mr. J. M. Schaeberle considers that the "best results which could be given by the lens alone could not be obtained if an intermediate reflecting surface were to be introduced, to say nothing of the effects produced in long exposures by a rotation of the image in position-angle, with a change in the hour-angle of the Sun." It is yet to be determined how serious is the first objection to the use of a mirror. The second objection, the rotation of the image, disappears when the mirror is used as a cœlostat, though this does not seem to have occurred to Mr. Schaeberle any more than to others who have done eclipse work. And yet Mr. W. W. Campbell writes (Pub. Ast. Soc. Pacific, vol. vii. p. 293), "the principles—and possibly the practice—of the cœlostat are well known in this country. As an example, I may perhaps mention that when Professor S. P. Langley was here, in 1893, he recommended that for certain purposes we mount the reflector of our heliostat with its plane in the axis of rotation and parallel to the Earth's axis, adjust the clock-work to a 48-hour rotation, and place the observing telescope in the proper horizontal position. These conditions are indentical with those required by M. Lippmann's cœlostat." So they are certainly; and it seems a pity the excellent advice was not taken.

I think the following paragraphs are amusing enough to be reproduced. The first is from *Tit-Bits* for Dec. 10—presumably a defective translation. The second from the *Daily Telegraph* of of Dec. 14.

"An Astronomer's Paradise.—On the high desert plains of Algeria the atmosphere is so clear and translucent that the satellites of Jupiter are visible to the naked eye, and the craters of the Moon on the dark surface of that luminary can be examined with a telescope.—*El Mundo Pintoresco.*"

"A London assistant-schoolmistress writes that she has now full conviction of the inutility of attempting to instil into the minds of nine-year-old girls a knowledge of the more recondite branches of astronomy. She says that, according to instructions, she explained to her class, some time ago, the uses and purposes of the zodiac. The other day she resumed the astronomy-lesson, and, in order to test the recollection of the pupils, she asked, 'What is the zodiac?' 'There aren't none now, ma'am,' replied a little girl; 'it's bust up.' 'What's burst up?' said the teacher, in great surprise. 'The sody'urk,' answered the girl, 'where they make the sody-water, and father's been thrown out of work.' Subsequent investigation showed that a soda-water manufactory in the neighbourhood where the girl lived had been closed—temporarily, at least—through the bursting of some steam-pipe, and the pupil had seen in this catastrophe the collapse of the zodiac. The lady says she thought it was useless to proceed further with her explanations of astronomy.

In a recent number of the 'Cambridge Review' it was announced that "another Newton MS., containing a transcript of the 'Principia,' with curious additions, had recently been acquired by Trinity College." It does not appear, however, that the acquisition is of any great importance. It seems to be a translation of the 1st edition of the 'Principia' corrected by the 3rd edition, and so was probably contemporary; but it only covers the First Book, and runs page for page with the first edition. It may possibly have been used for teaching purposes by some tutor of the period. The purchase of it by Trinity College is evidence rather of the care taken by the College to preserve anything connected with Newton than of great intrinsic value in the MS. itself.

The new variable which Dr. S. C. Chandler has discovered, with a period of 5½ hours only, opens up new possibilities in this department of astronomy. It means more work of course, but work of a delightful kind; for the tedium of waiting for something to happen is eliminated—something is going on all the time. An account of the star is given in No. 358 of the 'Astronomical Journal.' I am glad to be able to report that the editor, Dr. Gould, is recovering slowly but surely from his serious accident (mentioned in these notes in October). He can walk a quarter of a mile or so, at a slow pace, and at the end of October attended the session of the National Academy of Sciences in Philadelphia.

A project for a univeral scheme of bibliography has been circulated by the Belgian Astronomical Society, supported by a number of eminent astronomers if we may judge by a list of names given in the circular. I am not sure, however, that the project is quite entitled to this support if I may judge from a single instance. My own unworthy name is on the list, somewhat to my surprise, as I did not remember the circumstances under which I had signified my approval of the scheme; and I summoned up sufficient courage to write to the Librarian of the Belgian Society to ask him to remind me of these circumstances. His reply is as follows:—"Dernièrement j'ai eu l'honneur de vous adresser quelques pages types de la Bibliographia Astronomica, en vous demandant de bien vouloir nous honorer de vos conseils . . . Le dernier paragraphe de ma demande disait que votre silence serait considéré comme une adhésion." I am afraid that my silence was not quite interpretable in this way, but I can only hope that my case was exceptional, and that the other names represent a more deliberate approval of the scheme.

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MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, January 10, 1896.

Dr. A. A. COMMON, F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. TURNER, M.A., B.Sc., and
E. W. MAUNDER.

THE Minutes of the previous Meeting were read and confirmed.

Mr. Maunder. 78 presents have been received since the last meeting of the Society. Of these, attention may be called to a little manual called "Telescopic Astronomy," by Mr. A. Fowler; and to some negatives of lantern-sides, made by Mr. Newbegin from Keeler's drawings of Mars which appeared in the memoirs of the Society. We have also received from Dr. Weinek some enlargements he has made from the lunar negatives of MM. Loewy and Puiseaux.

A vote of thanks was accorded to the donors of these presents.

Prof. Turner. We have received an important paper by *Prof. Barnard* on micrometric measures of the Ball and Ring System of Saturn and of the diameter of his satellite Titan, with some remarks on large and small telescopes. In the 'Monthly Notices' for May 1895, Prof. Barnard gave a series of measures of the Ball and Ring System of Saturn made at the Lick Observatory during 1894. In 1895 the measures were repeated with the same instrument, so that the final results now published rest on two years' observations. The 1895 measures were in the main accordant with the results of 1894. In the opposition of 1894 no direct measures were made of the inner diameter of the crape ring; during the opposition of 1895 this ring was measured directly, and the value of its diameter given by the present measures is to be adopted. Remarking that much discussion had arisen over the apparently abnormal lack of detail shown in his previous observations of Saturn with the 36-inch, the general impression seeming to be that great telescopes are inferior to smaller ones for showing the delicate markings on the surface of a planet, Prof. Barnard in his paper gives details of several nights' observations, when he made experiments by observing planets with the full aperture of the telescope, and with a diaphragm over the object-glass to reduce the aperture to 12 inches. These experiments were made to determine if, as is thought by some astronomers, a reduction of the aperture would make it possible to see details that are not visible with the full aperture; but Prof. Barnard remains convinced that everything that can be seen with the area of the O.G. diminished can be seen with the full aperture, and, further, that such details can be seen better with the full aperture when the air is steady. At the opposition of Saturn in 1895, as on all previous occasions, no spots were seen upon the planet with *any* aperture, either in early twilight, at dawn, or after dark. Prof. Barnard repeats his opinion that it is better to reduce the light by a cap with a small hole in it placed over the eyepiece, than by placing a diaphragm over the object-glass, and sums up by saying that, in his experience, the large telescope is best for planetary and some other visual work, but for large and diffused nebulæ he prefers a smaller one.

Dr. Spitta. I should like to ask whether putting a diaphragm over the eyepiece has a different effect to diminishing the aperture of the object-glass. Perhaps the President will be able to enlighten us.

The President. It seems to me that the two methods give exactly the same effect.

Dr. Spitta. But in his paper Prof. Barnard says the effect is different.

Capt. Noble. I should like to make two remarks in connection with the paper. The first is that the spots which were seen upon Saturn were seen by Mr. Stanley Williams at Brighton, and others. Now, if Mr. Stanley Williams did not see them, I am perfectly certain he would not have said he did; he is a skilful observer and not an imaginative man. The reason why Prof. Barnard did not see them may possibly be found in Prof. Keeler's paper, in which he discussed the spherical aberration of this object-glass. When I read the figures I was astounded at the amount of the aberration in this large telescope; and with that amount of aberration I do not wonder a bit at his not seeing the spots.

Sir Robert Ball. In a subsequent part of the paper Prof. Barnard describes the multitudinous details he has seen on Mars in the region of the "Kaiser Sea" and on other parts of the Martian surface, which does not look as if spherical aberration interfered to a great extent with the performance of the object-glass.

Mr. Newall. As I have seen through the Lick telescope, perhaps I may be allowed to make a remark upon its performances. I was fortunate in being able to look through it on two different nights, when the seeing was extremely good, and I confess I was amazed at its performance on small double stars and on tolerably bright stars also. The only thing that has surprised me with respect to the telescope is that only eight inches of the diameter of the object-glass has been used in photographing the Moon. I did not realize what the reason for this was until the third volume of the 'Lick Observations' was published. It then appeared that this was done partly because of some defect in the photographic lens: that is, a third lens which is put in front of the big object-glass when it is used for photographic purposes. Chromatic aberration may be left out of account altogether when one is concerned with looking into the details of planets, and it seems to me that the remarks Prof. Barnard makes about the fineness and accuracy of detail seen with large instruments are perfectly true. On the 25-inch equatorial at Cambridge there is an extremely good finder of 6½ inches aperture, and there are many nights when the sky is bad for observing when the 6½-inch is found to perform as well as the 25-inch; but as a practical matter I would not hesitate on any night to use the 25-inch for looking at the detail of a planet in preference to the 6½-inch. I can fully corroborate the remarks about the effectiveness of the big telescope.

Mr. Maunder. I should like to support what Mr. Newall has just said. There is a good 6-inch telescope attached to the 28-inch at Greenwich, and when I have had an opportunity of looking at Mars or Jupiter with the great telescope, the difference has been very perceptible between the defining-power of the larger and the smaller telescopes. I should certainly much prefer to use the larger telescope for planetary work.

The Astronomer Royal. I do not know that I can say much on the subject of the relative advantages of different-sized telescopes, but there is one consideration always to be borne in mind; and that is, that in the use of a large telescope there is a very much larger area of the atmosphere affecting the image, and when the air is in a tremulous condition the image is liable to be affected, and naturally a high power cannot be used with the same advantage as when the atmosphere is quite quiet: so it is disappointing in some ways to possess a large telescope because it can only be used under exceptional conditions of the atmosphere; but when the air is in a quiet state there is no doubt that a great deal more can be seen with a large telescope than with a small one. With a small telescope on a very bad night it is possible, perhaps, to see nearly as much as with a big one; but if the atmospheric opportunities are properly chosen, one can no doubt see very much more with a large telescope for short intervals of good definition than with a small one, but one has to watch very patiently for these fits of fine definition and make the most of them when they come.

Prof. Turner. I remember sometime ago Mr. Wilson, now Archdeacon of Manchester, remarked to me that he had devised an arrangement attached to the Rugby telescope by which he could gradually reduce the aperture on bad nights until he got the aperture quite suitable for the occasion. I should like to call attention to the contrivance he used, which is an ingenious adaptation to practical purposes of a geometrical figure known to mathematicians. A series of many strings are led from the rim of the object-glass to a parallel ring, the strings thus forming a cylinder. By rotation of the upper ring about the axis of the cylinder the strings incline and form a hyperboloid of one sheet, the central section of which is always circular, and forms a diaphragm, whose diameter diminishes as the ring is rotated. I have never seen this contrivance in any optician's workshop, although we are familiar with other contrivances which give a closing polygon instead of a circle.

Mr. Robinson. I should like to ask to what extent it might be expected that observations made at Mount Hamilton would differ from those made at lower levels. Mount Hamilton is 4000 feet high, and with different climatic conditions an observer might be expected to get better definition, so that we cannot compare his results with those got from observations in a country like this, and at an altitude not much above the sea-level.

Rev. W. Sidgreaves. The behaviour of large objectives is an interesting subject to me, in connection with the Perry Memorial 15-inch refractor. I have made no special attempts to test its resolving powers. I have devoted practically all the available nights to one end, that of getting the best spectroscopic results with the means at my command. But I have, of course, occasionally tried its powers on the planets, &c.; and I must acknowledge that I have never seen anything approaching the exquisite drawings which I have seen in some of our astrophysical publications. When, however, I turn to an object like the nebula of Orion, which has been photographed, I am at once struck with its appearance as precisely that of Dr. Roberts' pictures of it.

The President. This subject about large and small telescopes is one that comes up for discussion very frequently. I recollect many years ago when I first began to work with the telescope reading all the literature I could get hold of relating to the performance of object-glasses of different apertures. I was much puzzled by the opinions expressed by various authorities as to the advisability of cutting down the aperture by $\frac{1}{4}$ inch or $\frac{1}{2}$ inch in order to see a star better. I could not understand, also, why a 10-inch object-glass should make a so much better telescope than a 12½-inch. I made experiments with my own telescopes by reducing the aperture and found that, as a rule, with a large telescope and a small magnifying-power I could see just as well as with a small telescope and a high magnifying-power. In telescopes made on the scale of the present day, where the aperture is from one-fifth to one-tenth of the focal length, the light of the major planets is too great for moderate magnification, for to see small details it is absolutely necessary to have neither too much nor too little light; there is a proper illumination suitable for the observation of every object. I remember one occasion when I was observing and saw Saturn defined most wonderfully,—I saw the crape ring and the other well-known details defined as I have never seen them before or since; and I found after the observation that I was using only a segment of the mirror about 9 inches in breadth,—I was, in fact, looking through the upper half of the tube and using the upper part of the speculum, possibly the part which was free from tremors. My impression is that we of the present day are making a great mistake in having telescopes of too small a focal length in proportion to the aperture for the examination of planetary detail. There is no doubt that the advantage of a large telescope over a small one is not only in the aperture but is also and principally in the greater focal length. There is not the slightest doubt but that the single lens of immense focal length of Cassini and Huyghens and others gave a primary image which could be seen with the eye and in its naked beauty without too much light. I had occasion in making the oblique Cassegrain telescope to investigate the size of the image given by the combination, and which is equivalent to large focal length, and I have an image of the Sun 14 inches in diameter. This is an enormous magnification. You can look at the object without an eyepiece and see it magnified to about 150 or 200 diameters. One thing which is very striking is the beautiful steadiness of the image. The primary image is formed upon such a scale that the magnification necessary is extremely small, and there is therefore a due proportion of light to size, and that is one of the things which is most lost sight of in comparing telescopes of large and small apertures. This subject is an extremely interesting one and gives rise to discussion which is even better than that on the subject of the relative merits of reflectors and refractors.

The Astronomer Royal. The question of reducing the intensity of light suggests to me that it would be of very great interest to compare the image as seen with the full aperture through cobalt glass or some such obscuring screen and the image formed by reducing the aperture. With the 28-inch at Greenwich we have been using cobalt glass as a screen between the eyepiece and the eye, which is found advantageous; and where the light is too intense to get the best results it is possible in this way to reduce it without reducing the aperture. I think it would be interesting if a series of experiments were made for the purpose of comparing the effect of reducing the light in various ways, first by glasses of different colours without reducing the aperture, and then by reducing the aperture. It is possible to reduce the light without reducing the aperture, and this method may give better definition.

The President. I recollect many years ago that on a certain occasion I could not see the companion of Sirius until I used a smoked glass wedge, and then I saw it. I wrote to the late Dr. Hind about this. I was able to see the small companion, but only with the full aperture and blue glass.

The Astronomer Royal. My remark might apply to Jupiter and Saturn, where the image is too bright to allow of the details being seen.

Mr. Newall. I have tried that plan on two nights when the planet was extremely bright and the seeing not very good, and I do not hesitate to speak in favour of using the darkened glass instead of cutting down the object-glass by means of a diaphragm.

Capt. Noble. Perhaps the Astronomer Royal would, at the same time as he makes the comparison he speaks of, have Prof. Barnard's own method tried with the others; that is, of cutting down the aperture of the eye lens. He seems to think that he retained all the advantage of the large aperture while cutting off the light at the eyepiece.

Mr. Newall. Without knowing anything of Prof. Barnard's method by experience, it seems to me that there might be a difference. In one case the contracted beam passes through the central part of the eyepiece, in the other case it may pass not centrally; the difference would then depend on the goodness of the eyepiece.

The President. My experience is that there is always one particular eyepiece which is always the most suitable one for any particular telescope. I have two or three eyepieces which work magnificently with one telescope, but which do not work well with another.

A vote of thanks was passed to Prof. Barnard.

Mr. Newall described the spectroscope recently constructed for use with the 25-inch equatorial at Cambridge, and exhibited pictures of it. It may be briefly described as a single-prism spectroscope transmitting a beam of light with circular section 2 inches in diameter; it has been designed solely for photographing spectra. A single prism has been used in order to avoid unnecessary loss of light; this prism has to be large in order that the desired resolving power may be gained. It had been found that a prism large enough to transmit a 2-inch beam gives a resolving power greater than a photographic film, with its strongly marked granularity, can do justice to, in that greater linear dispersion than can be used advantageously in stellar spectroscopy. The requisite linear dispersion (*i. e.* length of spectrum on the photographic plate) has been obtained by the use of a long camera; and in order to avoid excessive linear dimensions in the apparatus, one of Dallmeyer's telephoto combinations has been used, so that the camera, whose effective focal length is 40 inches, is only 20 inches long. A correcting lens is used to alter the character of the colour correction of the equatorial, so that a greater range of spectrum can be photographed; and this lens is of such form and so placed that the corrected focus is 18 inches nearer to the object-glass than the uncorrected focus. The spectroscope is pushed partly into the tube of the equatorial, and many advantages are thus gained. The difficulties that might have been anticipated as likely to arise from the inaccessibility of the slit have been entirely avoided by the use of Dr. Huggins's admirable device of the reflecting slit-plate.

Mr. Newall also showed photographs of spectra taken with the spectroscope to illustrate some remarks about the enormous difference between the exposures necessary with a slit-spectroscope and an objective prism, by showing on the screen some enlargements of photographed star-trails, from which it was evident that the star would, on such a night as that in which these photographs were taken, have been more frequently off the slit than on it. In fact, actual measurement of the trails showed that the star would, even in a liberal estimate, have been on the slit only two-fifths of the whole time of exposure.

Rev. W. Sidgreaves. The loss of light in its passage through an ordinary spectroscope attached to the eye-end of a telescope is an interesting subject, and Mr. Newall's photograph of the trail of a star's image is very instructive; but I do not think that it accounts for all the difference of light-intensity as given by the objective prism and by the eye-end prism. Mine is a slitless spectrograph at the eye-end of the telescope, and loses not more light than the objective-prism spectrograph, by the oscillations of the star's image as observed by Mr. Newall; and yet the loss of light through the eye-end optical system is very great, when compared with the behaviour of the objective prism. The photographs obtained at South Kensington with a 6-inch prism and lens are stronger and longer at a much quicker trail than those obtained at Stonyhurst, with the 15-inch lens and small prism. I think the difference greater than can be accounted for by the extra surfaces of reflection.

The Astronomer Royal. I would like to ask Father Sidgreaves what is the thickness of his prism and what glass it is made of.

Rev. W. Sidgreaves. The central prism of the system of three is of dense glass. The length of the compound prism is about 4 inches; it seems to be of white clearness.

Mr. Newall. I should like to say that I often make a point of looking through the tube at the object-glass without the eyepiece before beginning work, the telescope being pointed to a bright star. I let the image of the star fall upon the pupil of the eye, so that I see the whole object-glass covered with light in the method well known to those who have studied scintillation. On good observing nights the object-glass appears nearly uniformly illuminated, but on nights not quite so good the circular disc is seen crossed by dark bars which are in rapid oscillation. The motion does not permit of their number being counted with accuracy, but it is possible to estimate their number roughly, and it seems to vary for different nights from 4 or 6 to 15 or 20. I have not been able to make a definite connection between the appearance of the object-glass and the goodness of seeing; but, speaking generally, the worse the night is for observing the greater is the irregularity of these bars, and on very many nights there are two sets crossing one another at a fixed angle so as to form lozenge-shaped bright and dark patches on the object-glass. The existence of these dark bars or patches may be attributed to a stoppage of light by irregularities in the layers of atmosphere through which the light passes; and from an investigation which Lord Rayleigh has made on this matter in connection with observations by Respighi and others, he concludes that the seat of these irregularities is in certain cases about 4 or 5 miles above the Earth's surface. The double set of lines seen across the object-glass may be connected with the difference in direction of air-currents above and below a certain stratum of air. I mention these observations in connection with Father Sidgreaves' inquiry because it has sometimes seemed to me that under certain circumstances it might be possible that the light-grasping power of a telescope depends not solely on the area of its object-glass but also on the relation between its diameter and the coarseness of scale of these scintillation patterns.

The President. I hardly gathered whether you mean to say that there was a variation in the amount of light which falls on the object-glass.

Mr. Newall. Yes; I did mean to say that.

The President. But you would not, on reconsideration, would you?

Mr. Newall. Certainly. There is an actual stoppage of light in the upper atmosphere. By "stoppage" I do not mean that there is opaque matter in the atmosphere, but there is some irregularity which diverts some of the light and does not allow it to fall upon the object-glass.

The President. But the question now is between the relative light-grasping powers of the object-glasses and the light which passes through the object-glass. I think on reconsideration you will agree that the matter depends on the light which falls on the slit and not on that which falls on the object-glass.

Mr. Newall. I quite agree that by far the greater part of the defalcation of light is at the slit.

Mr. Waters. Would it be practicable to take an instantaneous photograph of the appearance seen on the object-glass that Mr. Newall has described?

Mr. Newall. I think such a photograph might be taken.

The President. It would be almost hopeless to attempt to get a photograph of any particular phase unless you took a series of instantaneous photographs, and then you might happen to get a picture of the particular image you wanted. The result would be similar to that found by M. Janssen when he attempted to photograph the mottling of the solar surface, and got a series of pictures which did not at all agree.

Mr. A. Taylor. When Mr. Newall uses the spectroscope, is the slit sufficiently wide to take in the whole range of the star? if not, the loss of light as compared with that received by the objective prism is accounted for by having a slit narrower than the diameter of the star-disc.

Mr. Newall. I have taken account of that; the slit is of such a width as to take in all the image of the star.

A vote of thanks was unanimously accorded to Mr. Newall.

The Astronomer Royal (giving the outline of a paper by Mr. Dyson and himself on the work of the Astrographic Chart). This paper is of the nature of a report,—drawn up mainly by Mr. Dyson, who has given much time and thought to the work of the Astrographic branch, on the work done lately in determining the positions of stars on plates taken for the Catalogue of the Astrographic Chart. The paper is therefore not suitable for reading in detail, but it may perhaps interest my hearers if I give a brief sketch of the course of the work. You are aware that Prof. Turner had proposed a method of reduction by measuring rectangular co-ordinates on the plates, and then, by comparing the corresponding measures of the stars on the overlapping portions of two plates, to determine "relative constants": that is to say, to find certain constants for a plate by help of which we are able to find from the co-ordinates of a star on one plate what the co-ordinates of the same star should be on the overlapping plate. That work was carried out to a certain extent, and these "relative constants" have been discussed and the probable errors of results determined. From that we came to the conclusion that it was probably better at this stage to adopt another plan. We now take the stars given in the Catalogue of the 'Astronomische Gesellschaft' as the basis of our work, and after deducing from the R.A. and Decl. the "standard" co-ordinates of each star, these are compared with the measured co-ordinates of these stars, and from this comparison the "absolute constants" of each plate are determined. By help of these absolute constants it is possible to convert the measured co-ordinates of every star on the plate into R.A. and Decl. It will be seen that this method involves a comparison of the places of the stars as given in the 'Astronomische Gesellschaft' Catalogues and on the photographic plates, the difference of the places appearing as residuals. So far as we can draw any conclusion at present from discussion of these residuals, it seems that the accuracy of the results drawn from the plates is greater than that of the catalogue, and that the residuals due to the catalogue places are in some cases large. It may be that to increase the accuracy of the Astrographic Catalogue we shall have to re-observe a large number of stars to form the basis of the work. But this is merely a suggestion; the work of reduction is now going on systematically on the lines just described, and we hope to find out various sources of error and make improvements. A summary of what has been done may be of interest. Of the plates taken for the Astrographic Catalogue 130 have been measured. The present rate of progress, now that an organized staff has been formed under Mr. Hollis, is about 180 a year, so that 5 or 6 years more will be required to measure all the plates. This seems a satisfactory result to arrive at, because when this scheme of measuring the plates was broached, there was some rather loose talk, and it was suggested that it would take 50 years to measure the plates for this catalogue of two or three million stars. It seemed to me that to embark on a work which would take so long was a measure to be deprecated, and that it would be better to limit the work if necessary, so as to finish it in a reasonable time. I think you will agree with me that if we can get the work finished in 5 or 6 years that will be a reasonable time in which to finish our catalogue of about 150,000 stars. I am now speaking only of the work at Greenwich Observatory. There are 17 observatories co-operating in the work and no doubt working as successfully on the same lines, so there is fair hope that this immense photographic catalogue will be finished in a reasonable time. The point upon which I felt very great anxiety was the reduction of measures, and I am glad to say these computations have been carried on comparatively rapidly, so that we are beginning to overtake arrears. The absolute constants above described have been found for 72 plates. About 40 of these have been done between October 1 and December 31, or at the rate of 160 a year, so that we are measuring about 180 plates and reducing about 160 a year. With our present staff I feel very well satisfied with this rate of progress, and I will take this opportunity of expressing my appreciation of the zeal and energy of Mr. Hollis, who is now superintending this work. There is another important point which has been lost sight of in the work of the Astrographic Chart, and that is the Chart itself and its publication. I have been making some efforts to get the plates reproduced in various ways, and as a first step transparencies have been taken from 37 negatives, and prints made from them by two processes. I have brought specimens here for inspection, and shall be glad to show them to anyone interested in this subject.

The following papers were announced and partly read:—

E. E. Barnard. "Measures of the Ball and Ring System of Saturn, and of the Diameter of Titan, with some remarks on Large and Small Telescopes."

Isaac Roberts. "Photograph of the 'Owl' Nebula M. 97, and of the Nebula ♅ V. 46 Ursæ Majoris."

Isaac Roberts. "Photograph of the Cluster ♅ VII. 66, and of the Nebula ♅ IV. 75 Cephei."

Nautical Almanac Office. "Details of the Total Solar Eclipse of 1896 August 8–9, for Kushiro, in the Island of Yezo."

Royal Observatory, Greenwich. "Observations of Occultations of Stars by the Moon, and of Phenomena of Jupiter's Satellites, 1895."

Royal Observatory, Greenwich. "Observations of Comet *d* 1895 (Brooks)."

A. Marth. "Ephemeris for Physical Observations of the Moon, 1896."

A. Stanley Williams. "On the Drift of the Surface Material of Jupiter in different Latitudes."

W. H. M. Christie and F. W. Dyson. "On the Determination of Positions of Stars for the Astrophotographic Catalogue at the Royal Observatory, Greenwich."

E. J. Stone. "Expressions for the Elliptic Coordinates of a moving Point to the seventh Order of small quantities."

The following gentlemen were elected Fellows of the Society:—

Hugh Lancelot Aldis, 67 Dieppe Street, West Kensington, W.; *William Ernest Cooke*, M.A., Observatory, Adelaide, S. Australia; *Alpin G. Fowler*, M.Inst.C.E., 1 Cambridge Road, Norbiton; *David Edward Hadden*, Alta, Buena Vista Co., Iowa, U.S.A.; *Rev. Robert Killip*, Sale, Manchester; *George Handley Knibbs*, University, Sydney, N. S. Wales, Australia; *Fredk. William McCarthy*, 20 Chepstow Place, Bayswater, W.; *Charles J. Merfield*, Dept. of Public Works, Sydney, N. S. Wales, Australia; *Hugh Griffith Quirk*, Bay Mount, Vico Road, Dalkey, Co. Dublin.

The following Candidates were proposed for election as Fellows of the Society:—

Thos. Edward Knightley, Architect, Clive House, Tulse Hill, S.W.

James Cavan, M.A., Eaton Mascott Hall, Shrewsbury.

THE BRITISH ASTRONOMICAL ASSOCIATION.

The second ordinary meeting of the current session was held on Wednesday evening, the 18th December, *Mr. E. Walter Maunder*, President, in the Chair.

The election of nine new members was confirmed by the meeting, and the names of seven candidates for election were read and suspended.

An unusually large muster of members crowded the theatre to hear a lecture by *Prof. Ramsay* on the discovery of Helium. The lecturer gave an interesting and detailed account of the various steps in the investigation, and exhibited the spectrum of Helium.

The President in thanking Prof. Ramsay, on behalf of the Association, alluded to the close connection that existed between chemistry and modern astronomy, and expressed the special indebtedness of the meeting to the lecturer, who, coming before them as a chemist, had furnished information of the highest interest to them as astronomers. He concluded by heartily congratulating Prof. Ramsay on the award to him by the Royal Society of the "Davy" Medal.

Mr. Schooling read a paper on Venus by *Herr Leo Brenner.* The writer recorded and discussed experiences of the visibility of the dark limb during 1895. He first observed it on June 4, when two-thirds of the disc was illuminated, and almost daily from that date up to Sept. 18, since which he had never seen it with certainty. The observations became increasingly difficult as the planet approached inferior conjunction.

A paper on Jupiter, also by *Herr Brenner*, was then read. The writer confirmed Mr. Lunt's observation of a dark spot, and drew particular attention to a very conspicuous garnet-red spot in the N. tropical zone. The spot was first observed on Nov. 10 in longitude 222°, and again on the 17th in longitude 218°, showing a drift of 4° in seven days. Another spot of the same colour and size, but of a different shape, was also visible at the same time, and both were so conspicuous as to promise long duration. Their peculiar motion made it very desirable that their passage across the Jovian central meridian should be noted as exactly as possible. The writer recorded observations of the "great red spot" on the 16th and 30th Nov. Referring to the discussions on the phase of Jupiter, he had himself never been able to detect it.

Mr. W. H. Maw said that the two spots referred to by Herr Brenner were undoubtedly very distinct just now. He had observed one of them on the 10th, and he made the longitude 222°, agreeing very well with Herr Brenner's observation. With regard to the question of the phase, Mr. Maw called attention to the very different appearance of certain markings as seen on the shaded limb and on the brightly illuminated limb. The shading on the side where phase ought to be seen was very marked at present, and was clearly visible on any decent night.

Mr. Lunt remarked that he had observed the two spots referred to several times recently. They were quite visible in a 2¼-in. refractor, and could be seen well in a 3¼-in.

Capt. Noble said that if observers who saw the dark limb of Venus brighter than the surrounding sky would try cutting off the actually illuminated limb by a bar or something of that sort, they would see the other go out. He had seen the limb darker than the sky over and over again, and had also seen it apparently brighter, but on shutting off the actually illuminated limb, the other always disappeared.

The President thought that Herr Brenner's observations indicated the merely subjective nature of the phenomenon he described. He congratulated Herr Brenner on his confidence in the exactness of his observations. He had not only solved the problem as to whether Venus rotated on its axis once in 24 hours, or once in its own year, but he had been able to determine the rotation period to the 1000th part of a second. This, with so difficult an object as Venus, was a very remarkable achievement indeed.

A paper contributed by *Mr. A. Stanley Williams* also dealt with the Phase of Jupiter. The writer pointed out that while the phase itself was so small as to be practically inappreciable, the shading at quadrature was very conspicuous, the point of greatest brightness shifting as much as 11° according as the planet was before or after opposition. It was to this darkening towards the limb opposite to the Sun that he had referred in a previous paper and not to the actual phase.

Capt. Noble said that it was in consequence of a drawing by a member of the Jupiter Section which had been submitted to him, showing the disc of the planet almost of a gibbous form, that he had thought it desirable to show geometrically how much of Jupiter's disc would really be cut off.

Mr. A. C. D. Crommelin gave an abstract of a paper on "The Computation of a Comet's Ephemeris." In reply to questions he stated that Perrine's Comet would probably be visible just after sunset on and after December 23rd. Brooks's Comet could now be observed at any hour of the night, but it was very faint and ill-defined.

ROYAL METEOROLOGICAL SOCIETY.

The Annual Meeting of this Society was held on Wednesday evening, the 15th instant, at the Institution of Civil Engineers, *Mr. R. Inwards, F.R.A.S.*, President, in the Chair.

The Report of the Council showed that the Society was in a satisfactory condition, 34 new Fellows having been elected during the year.

Mr. Inwards devoted his Presidential Address to the subject of "Meteorological Observatories," which he illustrated with numerous lantern-slides. After describing some ancient observatories, including the Nilometers and the Tower of the Winds at Athens, he gave an account of National Observatories, of which the Royal Observatory, Greenwich, was taken as a type. High-level observatories were next described, of which that on Mount Blanc was taken as a type. Special reference was also made to the observatory on the Sonnblick, the high-level observatory at Arequipa on the Andes, and that on Ben Nevis. An account was next given of Tower Observatories, together with some of the results obtained from the Eiffel Tower at Paris. Mr. Inwards, in concluding, said: "One can figure to oneself a tower piercing the air from any of the elevated tablelands of this country—Salisbury Plain, the Stray at Harrogate, or the downs between Guildford and Dorking—and from which the most interesting results could not fail to accrue. It is the opinion of M. Vallot, no mean authority, that a high tower is for air-observing purposes equivalent to a mountain station of ten times the altitude; and this is plain when one considers that any mountain must act as an obstacle which thrusts upward the strata of the atmosphere into a form almost like its own; so that some of the effects are very little different from those observed below: while a tower like the Eiffel

Tower thrusts itself in the air without obstructing its movements. It is the boast of the Royal Meteorological Society that it is gradually covering the country with a network of private observing stations, and is collecting together, for the enlightenment of all future time, a mass of accurate knowledge on the subject of the changes in our atmosphere—its varying moods, its beating pulses, its calms, and its convulsions; so that when the philosopher is born who is destined to unravel all its mysteries, he will have the tools and instruments ready to his hand."

Mr. E. Mawley, F.R.H.S., was elected President for the ensuing year.

The Objective Prism and the Motions of Stars in the Line of Sight.

M. Orbinsky's proposed method for employing an objective prism for the determination of the radial velocities of stars, recalls to my mind several suggestions for solving the same problem, which may possibly be of some service in conjunction with his mode of procedure.

So long ago as 1875, at the very commencement of this research at Greenwich, it occurred to me that a motion of approach would not only diminish the wave-length of any particular line in the spectrum of a star, but would also increase the length of the spectrum between any two lines. So that, if an objective prism were used, the direction and rate of motion of the star could be determined by simply measuring the distance apart of say the C and *G* lines. This could be done by using a micrometer with one fixed and one movable wire. One line might be brought up to the fixed wire whilst the other was bisected by the moving wire. Or another method which occurred to me was to have a series of fixed wires, and allowing the spectrum to transit across the field, to tap off on the chronograph the time when the selected lines reached the several wires. The prism would in this case be fixed with its refracting edge parallel to the declination circle. My attention had been called to the use of the objective prism by Secchi's high praise of it as a light-saving arrangement, for the loss of light in the spectroscope then in use at Greenwich was enormous. We were also experiencing considerable difficulty in a satisfactory arrangement of the comparison light, and it seemed to me that a method which gave a very bright stellar spectrum, and which did not permit the use of a comparison spectrum, was precisely what we needed. But on working out the problem it became clear that the quantity to be measured would be so small as to leave little hope that it would be satisfactorily dealt with; the transit method certainly would not be a practical one. Besides, no objective prism was then available at Greenwich; and not only would a prism be needed, but a specially corrected object-glass, so that the two parts of the spectrum designed for measurement might be in focus at the same time. And *direct* measures of the displacement would be difficult, for the amount to be determined would be near the limit of errors of observation. For an approach of 10 miles a second would mean a lengthening of the distance between C and *G* by only 14 parts in 100,000.

Eleven or twelve years later the magnificent photographs of stellar spectra obtained by Prof. E. C. Pickering at the Harvard College Observatory, drew the attention of all astronomers to the great value of the objective-prism method when used in conjunction with photography for obtaining a record of the details of stellar spectra. Three plans then occurred to me for getting over the difficulty attaching to the object-glass prism, viz., the want of any way of determining the wave-lengths of the lines shown. As before, however, the plans on full consideration did not appear to me to promise to give the wave-lengths of the star-lines with sufficient delicacy for displacement work, and I therefore did not publish them. The method proposed by M. Orbinsky of taking the spectra of two or more stars on the same plate and measuring from a given line in the one spectrum to the corresponding line in the other, would probably overcome the difficulty which I felt, especially as Prof. Vogel has succeeded in measuring the displacement of the lines in the spectra of some of the brighter stars with great accuracy. These latter stars would serve as standards, and one or other of them could always be included in the spectra photographed on any plate. There may therefore be some use in mentioning these old ideas of mine now.

1. The first method of which I thought was to use in conjunction with telescope A, to which the objective prism is attached, a second telescope, B, rigidly attached to it throughout its entire length, but instead of being parallel to it, as is the case with the guiding telescope of the Astrographic instrument, it would be fixed at such an angle as to point directly to the star, the spectrum of which was in the centre of the field of telescope A. Further, the two telescopes would be so placed that their optical axes intersected at their common focus. Telescope B would be of smaller aperture than telescope A, and a revolving disc with an adjustable opening should be arranged before its object-glass, so that the effective exposure given to the image of the star in B might correspond to the exposure given to its spectrum in A. A finder, C, of considerable size, should also be provided. This would be mounted parallel to B, and the star brought very carefully up to the cross-wires, which must correspond exactly to the centre of the field of B. The plate after development would then show the spectrum of the star as given by telescope A, crossed at its centre by a line which would be the trail of the star itself. The plate might then be moved a short distance in the direction parallel to the equator, *i. e.* at right angles to the length of the spectrum,

and a photograph of another star taken close by the side of the first, and so on.

2. The second method was to directly measure the refractive angle for different parts of the stellar spectrum. In this method, a single telescope with its finder would alone be required, but the objective prism would have to be so mounted as to be easily and safely swung on one side. The finder would be provided with a series of wires placed parallel to the equator, as well as with one wire at right angles to it.

The method of observation would be to photograph the spectrum reading the declination circles with great care. Then turning the prism out of the way, to point directly on the star and expose again, again reading the declination circles. It would be found well to take a series of photographs of the star at short intervals of declination, so that a series of images of the star might be obtained along the edge of the spectrum. The horizontal wires in the finder would be arranged at suitable intervals, so that when the star was successfully brought to their intersections with the vertical wire, its image would fall at convenient positions with regard to the stellar spectrum.

3. The third method was for use where the telescope available had a considerably larger aperture than the object-prism. In this case, beside the spectrum of the star commanded by the prism, there would be produced on the plate the images of the stars to which the telescope itself was directly pointing. There would be no difficulty in identifying these, and their declinations being known the refractive angle corresponding to a line in any part of the spectrum could be readily inferred.

The three methods would all alike give a means of determining the refractive angle for different lines. But the third method would be open to the serious objections that the photographs of the stars and of the star-spectrum would be taken with different parts of the object-glass, and neither with the full aperture, and that the observations would have to be corrected for atmospheric refraction. The second method would probably be the best, provided the equatorial was supplied with a sufficiently good declination circle. E. W. MAUNDER.

On the Motion of the Double Star Σ 305.

THIS star deserves notice, as in all probability it will eventually be found to be a binary. The first observation was by W. Struve in 1829, but measures have by no means been continuous. Fortunately this is not of much importance, by reason that they occur in such a manner as to fix some ten positions fairly accurately. These positions are here given, with the number of nights' observations on which they depend :—

Epoch.	Pos.-angl.	Dist.	Nights.
1831·19	331°·2	1″·57	4
42·21	325 ·5	1 ·95	10
46·28	324 ·6	2 ·19	6
53·74	322 ·3	2 ·32	6
60·15	322 ·0	2 ·34	10
66·46	321 ·6	2 ·61	4
72·25	319 ·1	2 ·52	5
76·49	320 ·7	2 ·78	14
81·48	319 ·0	2 ·86	8
84·48	318 ·4	2 ·87	6
92·80	317 ·1	2 ·92	10

When these positions are plotted it is at once seen that they lie very nearly on a straight line, although a slight curvature is quite apparent. The motion along this line is, however, by no means uniform motion, but appears to correspond to motion in a curve, which is nearly in the visual plane. To show this without the help of a diagram, the following measurements along the line have been made:—

From 1831·19 to 42·21 (11$^{\text{y}}$·02) the distance passed over is 0″·43
„ 42·21 „ 53·74 (11 ·53) „ „ „ ·38
„ 53·74 „ 66·46 (12 ·72) „ „ „ ·30
„ 66·46 „ 76·49 (10 ·03) „ „ „ ·18
„ 76·49 „ 84·94 (8 ·45) „ „ „ ·12
„ 81·48 „ 92·80 (11 ·32) „ „ „ ·08

which show an undoubted slackening of speed at each period. Further, the areas swept out along the curve are fairly constant if the curve be given preference. It will be readily seen that observations of this system during the next few years will be of great importance, and it will probably be found that the companion has just passed apastron. The place of the star for 1900·0 is R.A. 2$^{\text{h}}$ 41$^{\text{m}}$ 48$^{\text{s}}$ and N.P.D. 71° 3′, and as the components are of magnitude 7 and 8 respectively, it is within reach of all observers.

T. Lewis.

Selenographical Notes.

Plato.—No area on the Moon has been more sedulously examined during the last 30 years than the floor of this beautiful formation, a circumstance due to the well-founded suspicion that it is occasionally the theatre of changes sufficiently obvious to be discovered in good instruments of moderate size. Few competent lunar observers who followed the exhaustive investigation by the late Mr. Birt of the phenomena presented from time to time by the minute white spots and delicate markings in the interior, recorded n the Reports of the British Association for 1871-72 and elsewhere, can well deny that a strong case for change has been established, however sceptical they may remain on the question of Linné, Hyginus N, and other controverted instances. The remarkable darkening of the floor also (an appearance not, however, confined to Plato) being not now considered to be due, as was once strenuously contended, to a physiological cause, renders it still more important that the locality should be kept under frequent observation. This, unfortunately, has not been systematically done during recent years, or, ere this, the question of change or no change might have been settled in such a fashion that no one would raise a doubt about it. The subject, nevertheless, crops up periodically when something which is deemed to be (and probably is) abnormal happens to be seen on the floor; but after a spell of transient excitement it is soon again forgotten. We are just now at a time when interest in Plato is again reviving, and one may hope that on this occasion it may be maintained till the question is set at rest. At 9^h, on October 4 last year, the Rev. W. R. Waugh, of Portland, when examining the interior with his 12½-in. speculum, saw several times an "excessively thin streak of light, similar to an illuminated spider-thread, in the position where Herr Brenner draws his yet unverified streak." The observation was confirmed by a friend who happened to be present. Mr. Waugh's streak appears to lie almost precisely in the position where a light marking was recorded in 1870–71, and, as he subsequently observes, was somewhat nearer the N.W. border than Herr Brenner represents it. During the December lunation, the Rev. T. H. Foulkes, M.A., of Devonport, observing with a 10½-in. speculum, noted two streaks, which seemed to be abnormally bright, on the western side of the floor; both were wedge-shaped, the broadest part of them abutting apparently on the wall. One extended in a S.W. direction from the N.W. border, and the other N.E. from the S.W. wall, and they nearly met on the floor about midway. It is specially noteworthy, though Mr. Foulkes only obtained transient glimpses of them, which were not repeated on subsequent occasions, that the wide ends of these streaks appeared to resemble clefts. There can, I think, be little doubt that these features represent two well-known markings frequently observed and recorded in Mr. Birt's report, referred to above. No features on the floor were more variable in visibility. Indeed, on the western side of the interior of Plato the apparent anomalies in the appearance and brightness of the markings were much more pronounced than elsewhere, and seemed to be governed by no ascertainable law. They were clearly not due to terrestrial atmospherical conditions or to changes in the Sun's altitude or azimuth. The idea of an obscuring medium of local extent and varying density which occasionally wholly or partially veils certain parts of the interior, and at other times disperses and allows the features below to be seen with extraordinary distinctness, seems to be the most feasible hypothesis to explain the phenomena. However this may be, it is hoped that enough has been said to induce observers to lose no suitable opportunity of paying special attention to the Plato markings just now and recording their observations.

Beaumont House, Shakespeare Road,
Bedford, 1896, Jan. 19.

T. GWYN ELGER.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Hind's Cometary Discoveries.

GENTLEMEN,—

It may be of some interest just now to recall the fact that the late Dr. Hind was the first discoverer of two comets. The first of these was noticed by him about 4 o'clock in the morning of October 19, 1846. It was a very faint telescopic object; he observed it until approaching daylight put a stop to its visibility, and noted that its motion was towards the south-east; but unfortunately the weather was so persistently cloudy in the early morning during more than three weeks after the discovery that no further observation could be obtained, and the nature of its orbit could therefore not be ascertained. It would have been reckoned as Comet IX., 1846.

The other comet was discovered by Hind on the evening of February 6, 1847, and was the first comet of that year. It was nearest the Earth about the beginning of March, and in perihelion on the 30th of that month, when it had increased so much in brightness as to be visible in full daylight. Hind first noticed a tail (about 30′ long) on March 9 when the comet was visible to the naked eye at night, its brightness being greater than that of a star of the fourth magnitude. Schmidt noted on the 18th that the tail was 4½ degrees in length. Hind states in Ast. Nach. No. 597:—"The comet was observed here [Regent's Park] at noon-day on March 30. It was first percieved at 11 A.M. with a power of 40 on our large refractor, the eye being protected from the intense glare by a light green glass. The nucleus of the comet was round or nearly so, beautifully defined and planetary. Two short rays of light formed a divided tail, not more than 40″ in length. At times I felt certain that the nucleus twinkled like a fixed star .... It appears to have been seen about noon by a clergyman residing in the island of Anglesey." It may be worth while to note that Arago gives in his 'Astronomie Populaire' a list of comets which are considered to have been visible in full daylight, but omits this. The great comet of 1843 was visible in many parts of the world during the day at the end of February, but had diminished considerably in brightness when it came into view here; and Hind remarks that in 1847 no comet had been visible in broad daylight in this country since the celebrated one of 1744.

The final and definitive determination of the orbit of Hind's comet of 1847 was made by Hornstein and published in the 'Sitzungsberichte' of the Vienna Academy for March 1854. The perihelion distance from the Sun was 0·04259, or about 3,961,000 miles; the inclination of the plane of the orbit to that of the ecliptic 48° 39′. Ellipticity was manifested, the approximate period, however, amounted to 10,818 years; so that we fear it would be only a bad joke to wish that any of our readers may live to see its return.

Yours faithfully,

Blackheath, 1896, Jan. 2. W. T. LYNN.

Eclipses and Chronology.

GENTLEMEN,—

I have been much interested in Mr. Russell's articles on *Ancient Chinese Astronomical Records*, which are published in the September and October numbers of 'The Observatory.' His dates, however, are astronomical, and should be increased by unity in order to correspond to the chronological designations which he has given.

According to his computation, the eclipse of B.C. 2137 was nowhere central, and was visible only as a partial eclipse in the northern provinces of China. But my own computation, as given in the April number of 'The Observatory,' shows that the line of central eclipse passed directly across Central China. The two computations of the eclipse of B.C. 2136 do not differ very much as to magnitude; but Mr. Russell's computation makes it take place near the close of the day, while mine shows that it came on about noon; and he regards the earlier eclipse as the more probable one of *Ho* and *Hi*, only for the reason that it happened nearly in the middle of the day. If it happened on the day of the equinox, it must have taken place B.C. 2136, Oct. 10.

Plutarch, in his 'Dissertation on the Lunar Spots,' gives an account of an eclipse of the Sun which had *recently* happened about midday. He states that the darkness was so great that stars became visible in all directions. It must therefore have been either total or very nearly total at the place of observation.

The determination of the date of this eclipse has hitherto baffled the efforts of all astonomers. It is known, however, that Plutarch was born about the middle of the first century A.D.; but the date of his death is unknown. It probably occurred before the year A.D. 130; so that the eclipse must have happened between the years A.D. 60 and A.D. 130. But if we examine all the eclipses which took place during the hundred years following A.D. 50, we shall find only one which corresponds to the narrative of Plutarch; and that took place A.D. 118, September 3. According to my computation, that eclipse was central and total at noon in longitude

27° 45′ east of Greenwich, and latitude 42° 38′ north: and at Chæronea, the residence of Plutarch, its magnitude was more than 10½ digits. It took place at 11^{h} 34^{m} in the morning, or only twenty-six minutes before noon, and thus corresponds perfectly with Plutarch's narrative concerning it.

It may be proper in this connection to give a comparison of the relative accuracy of my value of the secular acceleration of the Moon's mean motion with that of La Place and Hansen, when applied to a remote epoch. For this purpose I have calculated the mean longitude of the Moon for the epoch of the Calyougham, which corresponds to the mean midnight between the 17th and 18th of February of the year B.C. 3102, at Benares in India. According to the Indian Tables, the Moon's mean longitude at that epoch was 306° 0′ 0″. Now the secular acceleration of the Moon, between the years A.D. 1850 and B.C. 3102, is—

	°	′	″
According to Stockwell..	5	1	8·4
„ La Place ..	6	19	4·8
„ Hansen ..	7	42	46·8

If we employ Hansen's value of the Moon's mean sidereal motion, together with the precession of the equinoxes as given by the writer in the "Memoir on the Secular Variations of the Orbits of the Eight Principal Planets," and which is published as No. 232 of the 'Smithsonian Contributions to Knowledge,' we shall find—

	Moon's Mean Longitude.			Errors.		
	°	′	″	°	′	″
According to Stockwell..	306	4	43·1	0	4	43·1
„ La Place ..	307	22	39·5	1	22	39·5
„ Hansen ..	308	46	21·5	2	46	21·5

Assuming the Moon's place as given by the Indian Tables to be correct, it follows that the error of La Place's theory is about eighteen times, and that of Hansen's theory is about thirty-five times greater than that of my own.

It thus appears that my theory of the Moon's motion not only gives, with great precision, the place of the Moon at that distant epoch, but also represents with singular fidelity all the well-authenticated eclipses of antiquity. Faithfully yours,

Cleveland, Ohio, 1895, Dec. 10. JOHN N. STOCKWELL.

GENTLEMEN,—

Will you allow me space for a few lines with respect to the last part of Prof. Stockwell's letter in your January number merely to point out certain considerations which he appears to have overlooked? Socrates tells us that the battle between Theodosius and Eugenius was fought early in the month of September, about four months before the death of Theodosius, which occurred in the following January. The eclipse to which

Prof. Stockwell refers took place on the 20th November, and could not have been at the time of the battle, whatever its year was. The engagement was twofold, Theodosius being partly defeated on the first day and completely victorious on the second; Eugenius was killed, and Arbogastes committed suicide two days afterwards. Nearly all the writers of the period speak of a great storm of wind from the east which much contributed to the victory. Zosimus alone mentions an eclipse in the words quoted by Prof. Stockwell; but as no eclipse could have occurred at the time, we must subscribe to Clinton's remark that he "inaccurately describes an eclipse in the first battle instead of a storm in the second." Some time ago I pointed out that many historians by a misunderstanding speak of an eclipse instead of a storm at the battle of Crecy.

There appears, then, no reason to question the received date of A.D. 394 for that of the battle and 395 for the death of Theodosius the Great; this being confirmed by the statement of Idatius, that an eclipse occurred in the eighth year of his successors, the date of which (A.D. 402) is confirmed by the calculations of Prof. Stockwell.

Yours faithfully,

Blackheath, 1896, Jan. 6. W. T. LYNN.

The coming Eclipse and the Solar Corona.

GENTLEMEN,—

Our thoughts will soon be directed to obtaining fresh knowledge of the solar corona, which it is hoped will be obtained on the occurrence of the total eclipse of the 9th August next. On such occasions it is interesting to look back upon early times, when the knowledge of the nature of that phenomenon was not only practically *nil*, but it was doubted whether the "luminous ring" seen to surround the disc of the Moon superimposed upon that of the Sun during a total eclipse pertained to the former or the latter. It is well known that Halley expressed great doubts upon the point when observing the eclipse of 1715, because though the ring appeared to him to be concentric with the Moon whilst he saw it (which would indicate it to be a lunar atmosphere), some observers thought the breadth of the ring increased on the west side of the Moon as emersion approached. Louville, of the Academy of Sciences of Paris, who had come to London for the purpose of observing this which was total there, was more positive in the view that the ring was exactly concentric with the Moon throughout.

The eclipse of 1724 was total in parts of the north of France and the south of England, but London was just outside the total phase, and the weather seems to have been very unfavourable in this country. It was observed by Cassini and Maraldi at Trianon, near Paris, and the observations of the latter appear to have been very carefully made, as he distinctly noticed that the corona was *not* quite concentric with the Moon, and also that her motion covered and uncovered its western and eastern portions successively. It will be of interest to quote his exact words:—"Au commencement de l'obscurité totale, la lumière nous a paru plus grande du côté de l'Orient que du côté d'Occident: au contraire, vers le fin de l'obscurité totale, elle a paru plus grande vers l'Occident qu'elle n'étoit vers l'Orient. Elle m'a paru aussi un peu plus grande sur le bord qui regardoit le Septentrion que sur le bord opposé, de sorte qu'elle ne paroissoit pas concentrique avec le disque obscur de la Lune." * (Mémoires de l'Académie Royale des Sciences, de la Année, 1715, p. 178).

It was not until eighty-two years after this time that Don José Joaquim de Ferrer, observing the total eclipse of June 16, 1806, at Kinderhook, in the State of New York, expressed again decidedly this view, which the total eclipses of 1842, 1851, and 1860 so fully confirmed. Thirty-five years have elapsed since the last of these, and now the battle-ground of progress has greatly changed. We are scientific owners of a part at any rate of the corona, but much yet remains to be learnt about it, especially of its exterior portions. May the observers next August be favoured with weather suitable for their purpose, and may they bring back a rich harvest of results! Yours faithfully,

Blackheath, 1896, Jan. 16. W. T. Lynn.

PUBLICATIONS.

Popular Telescopic Astronomy †.—Mr. Fowler's method of teaching the construction and theory of the telescope reminds us of Mr. Squeers' spelling-lessons, only in this particular, that he combines practical manual work on the subject in hand with his verbal teaching. The book begins by giving precise instructions "How to make a Telescope" with a 2-inch object-glass and tubes of brown paper or cardboard—in fact, the publishers are prepared to supply for small sums the paper tubes and all the parts necessary for this purpose. In the course of these instructions there naturally occurs some information on elementary optics, brief but lucid, and also some practical hints on the use of a telescope. The remaining and greater part of the work is taken up by a description of the celestial objects that may be seen with an instrument of this size—the Sun and Sun-spots, the lunar craters, the planets,—and by lists of double stars, &c. The book, while not calling for any lengthy review, is sound, as might have been expected, remembering the author's practical experience, and, whilst it can hardly be said to add to the knowledge of the advanced astronomer, can be well

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* Part of this was quoted in my letter in the 'Observatory' for June 1892 (vol. xv. p. 264).

† 'Popular Telescopic Astronomy.' By A. Fowler, A.R.C.S., F.R.A.S. (George Philip & Son, London, 1896.)

recommended for the use of such a beginning observer as would be likely to make a modest instrument for himself before taking up more serious work.

CHANDLER ON THE CONSTANT OF NUTATION (A. J. No. 361).—Those who have followed Dr. Chandler's papers on the latitude variation will remember that among the data he discussed were the observations made at Greenwich with the mural circles by Troughton and by Jones in the years 1825–1848 (A. J. 313, 315, 320), and which he re-reduced to the epoch 1830·0 with Struve's value of the precession constant and Peters' nutation; aberration constant 20″·500; Boss's proper motions; Bessel's refractions; and Mean Latitude 51° 28′ 38″·42. (As these circles were 0″·07 N. of the present transit-circle, this value of the latitude would appear to make the Greenwich adopted value of 38″·10 too small by 0″·25.)

Starting with the assumption that in order to free the value of the nutation constant from the effect of known variations of short period it is necessary to base the determinations upon a very considerable number of stars distributed as uniformly as possible over the whole sky, Dr. Chandler considers that these Greenwich mural-circle observations provide an almost ideal basis, by their high quality as well as by their number (20,294), for a precise determination of this constant. His discussion on this basis gives the value 9″·192±0·012 for the nutation constant, and affords evidence of a 12-year period in the latitude variation, with a range of a quarter of a second of arc, which may be expressed by the formula $\phi - \phi_0 = -0''{\cdot}12 \cos (t - 1829{\cdot}5)\ 30°$.

The ideal in astronomy is the attainment of absolute accuracy, and the bases for that ideal are observations made by human beings whose faculties for absolute accuracy in recording sensations of sight or sound are known to be limited, and discussions such as these tend to raise the question as to what is the limit of accuracy to which we can expect to attain in determining the value of this and kindred constants. Before an answer is given to this particular question it may be well to wait for further materials to accumulate, but if the different results given by the same star for different epochs may be taken as a criterion of the value of the method, then this particular method of determining this constant does not seem to be free from objections. That the difficulty of obtaining any large number of stars which shall have been continuously and sufficiently observed over such a period as nineteen years is very great is evident, as Dr. Chandler has only got 34 stars between declination +6°·0 and +88°·4, of which the great majority are bright stars which can be and are observed at any time throughout the 24 hours in the course of the year, and of which the accidental and systematic errors are considerable.

In Table I. Dr. Chandler gives the results of the equations of condition for finding the correction $\Delta\nu$ to Peters' nutation constant of the form $x + by + c\Delta\nu = \delta - \delta_0$, where x is the correction to an assumed mean value δ_0 of the declination of each star, b is the interval of time reckoned from 1825, y is an unknown embracing the correction to the assumed proper motion as well as any element which may affect the observations depending on the time, and c is the coefficient of the nutation constant.

Grouping the values of $\Delta\nu$ as given in this table under the heading B′ for every six hours of right ascension, and taking simple means, and giving underneath the number of stars and Chandler's combined weights, we find:—

R. A.	0^h–$5^h{\cdot}8$	$7^h{\cdot}4$–$12^h{\cdot}1$	$14^h{\cdot}0$–$17^h{\cdot}5$	$18^h{\cdot}5$–$22^h{\cdot}9$
$\Delta\nu$	−0″·083	−0″·009	+0″·007	−0″·010
No. of stars	9	6	8	11
Combined weight	231	129	188	389

From which it would appear that the values of $\Delta\nu$ 12 hours apart, roughly representing summer and winter, show a marked discordance; and though it may be only purely accidental, yet it seems to show that a much larger number of stars would be desirable, although we admit the difficulty of finding the material.

Again grouping these same values of $\Delta\nu$ in order of declination, and taking simple means, we get

δ	6°–20°	20°–30°	30°–60°	60°–88°·4
$\Delta\nu$	+0″·040	+0″·015	−0″·080	−0″·101
No. of stars	12	8	7	7
Combined weight	205	201	267	261

Here, again, the values of $\Delta\nu$ show still more definite discordances, this time depending on declination. Two years ago the writer took several of the stars here chosen by Dr. Chandler, and after having reduced the Greenwich results of the years 1836–1893 (embracing three nutation periods) to the epoch 1890, deduced corrections to the nutation constant of Peters. Prof. Newcomb has also taken Greenwich observations of the same stars for the two periods 1851–1869 and 1870–1888*. The comparison given below of these results with those of the present investigation will probably be of interest, as showing the different values which are given by the same stars at different epochs:—

Star.	Chandler, 1825–1848.	Newcomb, 1851–1869.	Newoomb, 1870–1888.	Thackeray, 1836–1893.
	″	″	″	″
α Androm	−0·08	−0·18	−0·14	−0·31
Aldebaran	+0·06	−0·15	−0·19	+0·15
α Orionis	−0·18	−0·28	+0·31	+0·03
Pollux	−0·04	−0·05	+0·15	+0·01
Regulus	−0·03	−0·10	+0·34	+0·16
Arcturus	−0·08	−0·21	−0·01	+0·01
α Coronæ	+0·06	−0·11	−0·01	−0·03
α Lyræ	+0·10	+0·13	−0·10	+0·09
α Aquilæ	−0·02	−0·02	−0·11	+0·11
	−0·02	−0·11	+0·02	+0·03

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* Astronomical papers of the American Ephemeris and Nautical Almanac, vol. ii.

In order to control the value of Boss's proper motions, Dr. Chandler has compared the mean declinations for 1830 with the Greenwich 5-year Catalogue 1890, with the Madison observations 1887–92 and the Pulkova Catalogues of 1845 and 1885, and fresh proper motions have been obtained, the mean values of the nutation under the two systems being 9″·204 (Boss) and 9″·194. Having lately also determined a fresh proper motion of several of these stars from the Greenwich observations 1836–1893, the following comparison will show the amount of discordance, which may exist even among the best determined proper motions. In those cases where Auwers' and Greenwich results are identical, it is to be understood that Greenwich results show no appreciable correction to Auwers' adopted values.

Star.	Boss.	Chandler.	Auwers.	Greenwich.
	″	″	″	″
α Androm.	−0·1669	−0·1646	−0·156	−0·156
γ Pegasi	−0·0185	−0·0188	−0·013	−0·013
α Tauri	−0·1918	−0·1952	−0·184	−0·184
β Tauri	−0·1807	−0·1776	−0·180	−0·164
α Orionis	+0·0068	+0·0038	+0·024	+0·024
α^2 Gemini	−0·0783	−0·0727	−0·079	−0·083
β Gemini..	−0·0575	−0·0611	−0·051	−0·051
α Leonis	−0·0010	+0·0005	−0·018	+0·008
α Boötis	−1·9940	−1·9966	−1·977	−1·990
ε Boötis	+0·0102	+0·0185	+0·001	+0·017
α Coronæ............	−0·0997	−0·0966	−0·094	−0·094
α Serpentis	+0·0339	+0·0411	+0·056	+0·048
α Lyræ...............	+0·2724	+0·2750	+0·295	+0·275
α Aquilæ	+0·3701	+0·3696	+0·384	+0·364
α Pegasi	−0·0501	−0·0485	−0·030	−0·046

In order to test the point as to whether the mean value of the latitude is the same in all the years under discussion, Dr. Chandler applies the values of x from the solutions of the equations of condition to the assumed declinations, and finds the residuals are as follows:—

	″		″		″		″
1825 ...	−0·02	1831 ...	−0·02	1837 ...	+0·03	1843 ...	0·00
1826 ...	−0·01	1832 ...	−0·05	1838 ...	+0·16	1844 ...	−0·05
1827 ...	−0·06	1833 ...	+0·08	1839 ...	+0·01	1845 ...	+0·21
1828 ...	−0·06	1834 ...	+0·12	1840 ...	−0·11	1846 ...	+0·11
1829 ...	−0·07	1835 ...	+0·06	1841 ...	+0·12	1847 ...	+0·26
1830 ...	+0·02	1836 ...	+0·18	1842 ...	−0·20	1848 ...	+0·05

This systematic deviation Dr. Chandler considers must be due to a change in the place of zenith, which may arise either from subjective causes or from an actual slow change in the latitude, and for various reasons he inclines to the latter as the more probable explanation.

It is needless to add that the whole discussion is full of the vigour which animates all Dr. Chandler's work.

W. G. Thackeray.

NOTES.

Comet Notes.—The following elements of Perrine's Comet have been deduced by Prof. Campbell from Lick Observatory observations on Nov. 17, 24, and Dec. 1 (Ast. Journ. 361). They agree closely with those of Prof. Kreutz, given last month:—

T.... 1895, Dec. 18·3257 Greenwich M.T.
ω.... 272° 35′ 38″
☊.... 320 26 19 } 1895·0.
i.... 141 39 23
log q.... 9·28387

The folowing ephemeris is for Greenwich midnight:—

	R.A.			Decl.			Brightness (Nov. 17=unity).
	h	m	s	°	′		
Jan. 29	19	39	20	6	41	S.	0·38
Feb. 8	19	43	16	3	50	S.	
18	19	45	44	1	3	S.	
28	19	46	40	1	40	N.	
Mar. 9	19	46	8	4	24	N.	0·10

At the end of February the comet will rise four hours before the Sun.

The following elements of Brooks' Comet are by Berberich (Ast. Nach. 3325). They are deduced from a large number of observations from Nov. 22 to Dec. 11, and do not differ much from those by Dr. Halm given last month:—

T.... 1895, Oct. 21·0903 Berlin M.T.
ω.... 298° 46′ 20″
☊.... 83 5 53 } 1896·0.
i.... 76 14 57
log q.... 9·92586.

Elements almost absolutely identical with these have been deduced by Mr. Jay Roy (Ast. Journ. 362).

The following ephemeris is for Greenwich midnight:—

	R.A.			N. Dec.		Brightness (Nov. 21=unity).
	h	m	s	°	′	
Feb. 3	2	3	33	63	11	0·02
8	2	8	12	63	3	
13	2	14	0	63	2	
18	2	20	44	63	7	
23	2	28	14	63	13	
28	2	36	20	63	34	0·01

The following is an approximate ephemeris of Faye's Comet. The brightness is still about 0·8 of that in September last:—

	R.A.			N. Dec.			R.A.			N. Dec.	
	h	m	s	°	′		h	m	s	°	′
Feb. 2	0	8	52	1	26	Feb. 14....	0	38	1	3	34
6	0	18	28	2	8	18....	0	47	58	4	18
10	0	28	11	2	50	22....	0	58	1	5	4

Mr. Kurt Laves gives in Ast. Journ. 362 a definitive orbit of Comet 1879 V. This comet was in view from Aug. 21 to Oct. 22, 1879, 129 observations being available. He deduces the following parabolic orbit:—

T	1879 Oct. 4·66221 Berlin M.T.	
ω	115° 26′ 23″	1879·0.
☊	87 10 58	
i..........	77 7 52	
log q	9·995463	

Dr. Bredichin has an article in 'Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg,' Oct. 1895, on the perturbations of Comet 1862 III. (the comet associated with the Perseid meteors) by Jupiter. He assumes the following elements for the comet:—

Epoch 1850·0.	
n	10458″·209
e	0·9612708
π	344° 40′ 23″
i	113 34 33
☊........	137 25 50
ω	152 45 27
log a......	1·3954263

n is the mean motion in 1 Julian year, π is reckoned on the old system. On the modern system it would be 290° 11′ 17″. (The sum of the values of π in the two different systems = 2 ☊.)

The deduced annual variations in the elements are:—

Increase of ☊ = 0″·7534
Increase of i = 0 ·7062
Increase of π = 0 ·0690
Increase of e = 0 ·0000003

Saturn will produce an annual increase in ☊ of 0″·2, so that on the whole ☊ increases 1° in 3800 years.

This comet was in perihelion 1862 Aug. 22·92, and has a period of about 124 years. A. C. D. C.

Minor Planet Notes.—Four new planets—CH, CJ, CM, CN—were discovered by Charlois on Jan. 7, Jan. 7, Jan. 17, Jan. 17, and two others—CK, CL—by Wolf on Jan. 7. The two planets CF, CG, whose discovery by Wolf was announced last month, prove not to be new, but identical with (352) and (175) Andromache respectively. CE may possibly = (188) Menippe.

M. Charlois has now discovered 87 planets in the aggregate. In the last twelve months there was one new planet to every four known ones on his plates.

Planet 396 is probably identical with a planet discovered by Palisa on April 21, 1887, but not numbered at that time.

CD has been numbered 408. A. C. D. C.

THE OCCURRENCE IN STELLAR SPECTRA OF THE LINES OF CLÈVEITE GAS*.—The sensational discovery made by Prof. Ramsay in the early part of last year that the line D_3, which had hitherto been seen only in the solar spectrum, appeared also in the gas given off by the mineral Clèveite, will be within the memory of our readers. It may also be remembered that Profs. Runge and Paschen then proceeded to make a detailed survey of the spectrum of Clèveite, to which we need not further refer here, except to say that Prof. Vogel has made a comparison of his spectrum of β Lyræ (communicated to the Berlin Academy on 1894 Feb. 8) with Prof. Runge's spectrum of Clèveite, with, as he says, a surprising result.

Of the twenty-eight lines in the spectrum of Clèveite gas between wave-lengths 3700 and 7070, which alone need be considered in comparison with star-spectra, eighteen appear in the spectrum of β Lyræ, one of which is the helium line D_3, and another, the most intense line of the spectrum of β Lyræ (λ 3889), is the strongest of the Clèveite lines.

This interesting discovery led Prof. Vogel to make further comparisons with other spectra, and proceeded first to compare spectrograms of the Orion stars, taken by Dr. Wilsing during the last two years, with the Clèveite spectrum; this group of stars being selected, as the line λ 4471 (Lorenzoni's *f*), which is typical of Orion stars, belongs also to the Clèveite spectrum.

To state briefly the result, in the spectra of the ten stars examined, on the average seven or eight lines which appear in the Clèveite spectrum were seen, the line λ 3889 appearing in all. Further investigation showed that of 150 first-type stars, no fewer than 25—besides the Orion stars and Spica, Algol, β Tauri, and η Ursæ Majoris, which are already known to be of the Orion class—contained the spectral lines of Clèveite gas. This led Prof. Vogel to plan a scheme for investigating the spectrograms of all stars of the first class down to the fifth magnitude, which work is now about one-third completed, and, further, has induced him to modify the scheme, which he proposed more than twenty years ago, for the division of the stars into spectral types, as he considers that these Clèveite lines supply excellent criteria to indicate subdivisions. The following is a brief *résumé* of Prof. Vogel's proposed subdivision of stars of Type I.:—

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* 'Astrophysical Journal,' 1895 December.

a. (1) Hydrogen lines broad, with no other lines.
    (2) Metal lines in addition to hydrogen, but no Clèveite lines; calcium line sharply defined and narrow.
    (3) Metal lines; hydrogen lines; the calcium line as intense as the hydrogen; no Clèveite.
b. Spectra in which, besides the still dominant hydrogen lines, the lines of Clèveite gas appear; also some metal lines.
c. (1) Spectra with bright hydrogen lines.
    (2) Spectra in which, besides the hydrogen lines, the lines of Clèveite gas, of calcium, magnesium, and other metals are bright.

NEW STARS.—Harvard College Circular No. 4 announces that a new star has been discovered by Mrs. Fleming in the constellation Centaurus. Approximate position for 1900·0 is given as R.A. $13^{h}\ 34^{m}{\cdot}3$, Dec. −31° 8′. The star does not appear on any of 55 plates taken between 1889 May 21 and 1895 June 14, but is first seen on a plate taken 1895 July 8, its magnitude being then 7·2. It appears on several plates taken since that date, its brightness gradually diminishing. The latest observation was on December 19, when it was observed with a 15-inch equatorial as a star of the eleventh magnitude. Attention was first called to this object on account of the peculiarity of its spectrum, which is like that of the nebula surrounding 30 Doradûs, but is not like those of the new stars in Auriga, Norma, and Carina, although the object is like them in respect that it quickly attained its full brightness and then soon began to fade.

The circular goes on to compare this star with other Novæ, and incidentally gives a list of all stars of this class, which may be considered worth reproducing:—

Constellation.	R.A. 1900.	Dec. 1900.	Mag.	Year.	Discoverer.
	d m	° ′			
Cassiopeia	0 19·2	+63 36	−5	1572	Tycho Brahé.
Cygnus	20 14·1	+37 43	3	1600	Janson.
Ophiuchus	17 24·6	−21 24	−4	1604	Kepler.
Vulpecula	19 43·5	+27 4	3	1670	Anthelm.
Ophiuchus	16 53·9	−12 44	5	1848	Hind.
Scorpio	16 11·1	−22 44	7	1860	Auwers.
Corona Borealis...	15 55·3	+26 12	2	1866	Birmingham.
Cygnus	21 37·8	+42 23	3	1876	Schmidt.
Andromeda	0 37·2	+40 43	7	1885	Hartwig.
Perseus	1 55·1	+56 15	9	1887	Fleming.
Auriga	5 25·6	+30 22	4	1891	Anderson.
Norma	15 22·2	−50 14	7	1893	Fleming.
Carina	11 3·9	−61 24	8	1895	Fleming.
Centaurus	13 34·3	−31 8	7	1895	Fleming.

Memoirs of the Royal Astronomical Society, Vol. li. 1892–5.—The index of this recently issued volume, is a striking example of the many branches into which the modern science of Astronomy divides. For the benefit of those of our readers who have not seen this book, we give a sketch of the contents:—Three memoirs relating to meridian observations, one involving a determination of the constant of nutation, all from the Royal Observatory, Greenwich; a valuable paper by Dr. Gill on determination of the divisions of a scale which has special reference to Astrography; two series of double-star observations by Maw and Seabroke; physical observations of Mars in 1892 by Dr. Keeler; a catalogue of nebulæ by Dr. Dreyer; Father Sidgreaves' memoir on the spectrum of Nova Aurigæ; an optical investigation by Mr. Dennis Taylor, which is especially interesting as being made by an expert in this branch; and, lastly, Prof. Sampson's erudite mathematical paper on the rotation and mechanical state of the Sun—altogether forming a most interesting volume.

The Proper Motion of Lacaille 8912.—Mr. R. T. A. Innes writes from Sydney:—"This star has a *comes* of magnitude 8·8, which has been micrometrically connected with it by several observers. As the following two examples will show, the apparent difference of the measures is considerable:—

	°	″	
1836·6	14·2	30·3	Sir John Herschel.
1894·9	0·0	44·4	Mr. Tebbutt.

"On plotting all the measures within reach, I find the change can be accounted for by applying a proper motion to Lac. 8912, mag. 5·8, of $0''\cdot289$ towards $158^{\circ}\cdot9$, or in R.A. $+0^{s}\cdot0103$ and in Dec. $-0''\cdot270$.

"This conclusion is not inconsistent with the meridian results within the errors of observation, but I have only access to a few recent catalogues.

"Position for 1875:—R.A. $21^{h}\ 40^{m}\cdot1$, Dec. $-47^{\circ}\ 52'\cdot2$.

"It will be noted that this proper motion is very similar to that of δ Capricorni, mag. 2·8, a star some 31° north of Lac. 8912."

Variable Star.—R. Doradûs $4^{h}\ 35^{m}$, $-62^{\circ}\ 19'$ [1880]. Mr. R. T. A. Innes also informs us that this star was about a maximum from Nov. 30 to Dec. 13, 1895, when he made it from 4·7 to 4·9, or a magnitude brighter than η Reticule (5·8). This maximum is considerably brighter than usual. Although called red by Gould in the A. G. C. and in Stone's Cape Catalogue, it is not to be found in Chambers' catalogue of red stars.

The efflux of time brings occasional losses to the staff of observatories as to other places. The latest such loss we have to record as happening at the Royal Observatory is in the case of Mr. George Stickland Criswick, who retired on pension, in accordance with the rules of the Admiralty service, at the end of January. Mr. Criswick joined the Observatory in 1852, and, except for a period of ten months ending March 1855, when he worked under Prof. Challis at the Cambridge Observatory, has been a member of the Greenwich staff ever since. Mr. Criswick was selected by Sir George Airy as one of the observers in the Harton Colliery pendulum experiment, and also took part in the telegraphic determination of the longitude of Valentia in 1862. He has served in almost every department of the Observatory, and when the Astrographic branch was established a few years ago Mr. Criswick was placed in charge, his special and accurate knowledge of photography and his aptitude for mechanical details rendering him peculiarly fitted for this post. We wish Mr. Criswick long life and good health to enjoy his well-earned retirement.

HIGH BAROMETER READINGS.—The meteorological circumstances of the past month are remarkable for two waves of extraordinarily high barometric pressure. The first happened at the beginning of the month. The Daily Weather Report of January 9 shows for 8 A.M. barometer readings (reduced to sea-level) of 31·06 at Stornaway and at Aberdeen, and 31·09 at Ardrossan, Ayrshire. To find a previous occasion when the barometer rose above 31 inches, we have to go back to 1820 Jan. 8–9, when the area of high pressure was over Leith and the barometer (sea-level reading) rose to 31·065 inches at that place. The highest reading at Greenwich on Jan. 9 of this year was 30·73 inches, which corresponds to 30·91 at sea-level; and again at the moment of writing this, Jan. 29 midnight, the barometer is standing at 30·74 inches, corresponding to 30·92 at sea-level. We believe this is the highest reading recorded at Greenwich since 1825, except that of 1882 Jan. 18, when 30·790 was recorded. The occurrence of two such high waves in a month is remarkable.

A NEW OBSERVATORY.—It is announced that an observatory to be used for educational purposes is being established in connection with the University of Minnesota, U.S.A. It seems that this is to be devoted chiefly to the branch now known as physical astronomy, as the principal instrument is to be an equatorial of 10 inches aperture, adapted for visual or photographic work, with a spectroscope and photographic measuring micrometer as accessories. Prof. Leavenworth, of Haverford College, Pennsylvania, is to have charge of this institution.

A certain weekly journal, in announcing the establishment of this observatory, remarks that the telescope is to be of 150 inches "*local strength.*"

WE welcome a miniature but useful addition to our reference library—the almanac for 1896 of the Astronomical Society of

Wales. The object of this publication is, it is stated, to supply a want felt by amateurs "who find the 'Companion to the Observatory' too advanced"—from which remark the substance of the book may be inferred. The feature which makes the book interesting to us is the almanac proper. This is built on the lines of the ordinary calendar, a fact, of which the date is the anniversary, being given for every day of the year; but the facts are all astronomical. Thus we are told the exact day on which the Lick telescope was first used, the date of Mr. Lockyer's birthday, when Brunnow died, and other such things, which, being collected here, may save a writer some time which would be otherwise spent in research.

THE STAR-CLUSTER PRÆSEPE.—Dr. W. Schur has made an accurate triangulation of this cluster and reduced his observations made with the heliometer at Göttingen in the years 1889 to 1893 with great care. The comparison with previous results, and more especially with the results from the Rutherfurd photographs, are of great interest and worth the attention of astro-photographers. The full title of the memoir is "Astronomische Mittheilungen von der königlichen Sternwarte zu Göttingen—Die Oerter der helleren Sterne der Præsepe," W. Schur (Göttingen, 1895).

DURING the present month two of the four Eclipses of the year will take place. The first of these, an annular Eclipse of the Sun on February 13, is of little interest except to observers at the Cape, and there the greatest phase will be seen only a quarter of an hour before sunset. The other is an Eclipse of the Moon on the evening of the 28th. This Eclipse is only partial, but, as the magnitude is 0·870, it is possible that the occultation of faint stars may be observed. A list of the stars which will be occulted, there are however only five, is given in the 'Companion.'

WE hope it is not too late to offer our congratulations, on his marriage, which took place on December 28th last, to Mr. E. W. Maunder, a former editor of this magazine and the present President of the British Astronomical Association. Mrs. Maunder is a lady not unknown in the astronomical world. As Miss A. S. D. Russell she served on the computing staff of the Royal Observatory from 1891 Sept. 1 until 1895 Oct. 31, when she resigned her post, and left the Observatory followed by the good wishes of all her colleagues. She has edited the 'Journal' of the British Astronomical Association since November 1894 with conspicuous success.

DR. WILLIAM HUGGINS, F.R.S., has lately been the recipient of honours from two foreign sources. He has been elected a member of the American Philosophical Society, Philadelphia, and more recently the Royal Academy of Sciences, Berlin, has created him a corresponding member of that body.

It is stated that an American expedition to observe the Solar Eclipse of next August has already started for Yezo near Japan: this is, indeed, beginning early. Prof. D. P. Todd is to be a member of this party.

The 40-inch O.G. for the Yerkes Observatory is still in the workshops of Alvan Clark, who is also at work on a 24-inch for Percival Lowell, which is to be in readiness for the observation of Mars at next opposition.

We hear that Mr. R. T. A. Innes is about to join the staff of the Royal Observatory, Cape of Good Hope, as Secretary to H.M. Astronomer.

From an Oxford Note-Book.

On Friday, February 14, after the Annual Meeting of the Royal Astronomical Society, there will be a dinner at the 'Criterion' Restaurant in Piccadilly, open to all Fellows of the Society and their friends (price 7*s.* 6*d.* each, not including wines). The arrangements will, in fact, be the same as those announced in these notes last year. Intending diners are requested to send their names either to the Secretary of the Society, or to Dr. Common, 63 Eaton Rise, Ealing, some few days beforehand, if possible, though it is hoped that those who cannot come to an early decision will not be deterred by this fact. This dinner after the Annual Meeting was once an important part of the proceedings, and, judging by the attendance last year, there seems every reason to hope that it is becoming so again.

"Ich selbst habe noch nie einen meiner kleinen Planeten am Himmel gesehen." Dr. Max Wolf has discovered 36 new planets in the years 1892–1895, but he has never had the pleasure of seeing one of them through a telescope! Strange are the uses of photography. The above sentence is taken from an admirable article in *Ast. Nach.* no. 3319, wherein Dr. Max Wolf gives an account of his work and methods. He has two 6-inch portrait-lenses, and gives exposures of two or three hours with these, with unwearying attention to the clock-driving. One of his great difficulties is the identification of the planets afterwards. This is easy enough, he remarks, when you have a big telescope like that at Nice; for the identification can be completed by visual observations. But he has no such instrument at Heidelberg, and must trust to another long-exposure plate.

In these days of wars and rumours of wars it is pleasant to be able to record an international exchange of compliments in the domain of science. During a visit to the factory of Messrs. Troughton and Simms the other day, Mr. Simms showed me with pardonable pride a very handsome present he had received from the Emperor of Russia on the completion of the Russian standard measures of length. The accompanying letter runs:—"His Imperial Majesty Nicolai Alexandrovich, Emperor of All the Russias, in regard to your special labours in connection with the preparation of new Russian standard measures, presents you with a box containing a silver tea-service." The silver is beautifully enamelled, and looks in every way worthy to be an Emperor's gift. The making of the standards has been a laborious undertaking, both for Mr. Simms personally, and for Prof. Mendeljeff and Dr. Bloumbach, who have visited this country to superintend the construction. All who have worked with Mr. Simms well know the value of his help and experience, so lavishly bestowed on any purely scientific object whenever occasion arises, and will join in congratulating him on this well-deserved honour.

PARAGRAPHS have recently appeared in several papers to the effect that Russia was at last contemplating the abandonment of the Old Style. One paper (I think *The Standard*) was so circumstantial as to say that the prospect of having *thirteen* days difference (as there will be if 1900 is observed in Russia as a Leap Year) had frightened the superstitious Russians, and sooner than run the risks which the members of the Thirteen Club are so anxious to incur, they had determined to give up the Old Style, either at once or gradually. On inquiry of the Director of the Pulkowa Observatory I learn that there is no foundation for these reports. Dr. Backlund writes that the question has not yet even been discussed in the Academy of Sciences, and to the best of his belief has not been raised in any other definite form.

THE occurrence of an astronomical joke in our leading comic journal is perhaps an event worthy of notice. In *Punch* for January 18 the following letterpress is suffixed to an appropriate picture by Mr. Arthur Hopkins labelled "An Astronomer":—

> MRS. S.: By the way, I hear Jupiter—the evening star—is worth seeing just now. Can either of you girls tell me where to look for it?
>
> BERTHA: Yes, I can. It's exactly two yards and a half to the right of the Great Bear.
>
> MRS. S.: Two yards and a half! What on Earth do you mean?
>
> BERTHA: Well, I've measured it carefully with my umbrella.

At 8 o'clock in the evening of January 15 (when the paper of above date appeared) we had a beautifully clear evening, after rain, at Oxford, and Jupiter was splendidly conspicuous "to the right of the Great Bear." But I had the curiosity to take out a two-foot rule, and found that, when placed at arm's length, it was amply sufficient to span the distance between the planet and the constellation. Either the young lady must have had arms much longer than appear in the drawing (say about 3 yards at least), or there must be an explanation similar to that given by the gardener in James Payn's 'Gleams of Memory':—"How is it that Mr. Brown and Mrs. Jones have such fine grapes, they tell me, and we have none?" "Well, I tell you how it is, ma'am," the gardener replied, "they lies."

As I have referred to this delightful book, I may perhaps quote a story from it *very* distantly related to things astronomical, and that through the real "evening star" whose name is above usurped. I have often described, says the author, though not in print, a delightful scene in which Burgon refused to christen a male child "Venus."—"Vanus? I suppose you mean Venus. Do you imagine I am going to call any Christian child after that abandoned female, and least of all a male child?"

The father of the infant urged that he only wished to name it after his grandfather.

"Your grandfather!" cried Burgon, "I don't believe it. Where is your grandfather?" He was produced: a poor old soul of eighty or so, bent double, and certainly not looking in the least like the goddess in question. "Do you mean to tell me, sir, that any clergyman ever christened you 'Vanus,' as you call it?"

"Well, no, sir; I was christened Sylvanus, but they always calls me Vanus."

A PAPER by Professor d'Arcy Thompson, of Dundee, on "Bird and Beast in Ancient Symbolism" (Trans. R. S. Ed. xxxviii. pt. 1, No. 3), would not at first sight appear to have much astronomical significance; but the gist of it is that certain astronomical phenomena seem (to the author) to be veiled or symbolized in art and in literature in connection with certain birds and beasts. The first example given is the great relief of Cybele in the Hermitage Museum at St. Petersburg, where a lion and a boy with a water-jug, of which no adequate interpretation has been otherwise offered, are taken to mean Leo and Aquarius; and two annular symbols, on the right and left of the shape ⊙, are taken to signify the Sun as at present; so that the Sun is typified in Leo and in Aquarius, "which were, in the epoch immediately preceding that of classical astronomy, *the tropical or solstitial signs.*" I cannot follow all the illustrations, or even this one in detail: those interested should refer to the paper. Perhaps the most striking is the bird on the back of the bull, which is taken to mean the Pleiades; and further "in considering the relative positions, at critical periods, of the Sun and the Pleiades, we seem to light on an explanation of the great myth of the Halcyon's Nest. On the day of the winter solstice, the Pleiades occupied at sunset the mid-point of the heavens. It was precisely at this period that the Halcyon was said to lay her egg, when the turning Sun rose to renovate the year."

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 238. MARCH. 1896.

ANNIVERSARY MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, February 14, 1896.

Dr. A. A. Common, F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. Turner, M.A., B.Sc., and E. W. Maunder.

Mr. Maunder read the Minutes of the last Anniversary Meeting, which were confirmed.

Mr. H. P. Hollis read the Auditors' report, which stated that they had examined the Treasurer's accounts for the year 1895, and found and certified the same to be correct. The cash in hand on 1895 Dec. 31 amounted to £349 1*s*. 8*d*. The Auditors added two notes relating to matters connected with the finances of the Society. The first proposed that a notice should be sent out with the February number of the 'Monthly Notices,' informing Fellows that their subscription for the forthcoming year was then due. The second was a suggestion that the time had come when Section V. of the Bye-laws, which related to the payment of subscriptions to the Society, should be revised.

The President at first objected to the second of these notes being read, on the ground that any proposal for alteration of the Bye-laws was out of order unless notice had been given, but on it being pointed out that this was of the nature of a suggestion to the Council, the objection was withdrawn.

The Secretaries read extracts from the seventy-sixth Annual Report of the Council. The Society during the year had lost by death the following Fellows:—Isaac Brown, James Campbell, Arthur Cayley, Sir James Cockle, E. J. Collingwood, Richard Dunkin, J. R. Hind, F. R. Hughes, A. L. Kaye, A. J. Melhuish, E. H. Nightingale, O. A. L. Pihl, Alfred White, and Associates, Gustav Spörer and Friedrich Tietjen.

Prof. Turner read extracts from the obituary notices of these gentlemen, and alluded to the fact that by the death of Mr. White the Society loses the last survivor of the Spitalfields Mathematical Society. On the break up of this Society, its library and all its records were transferred to the Royal Astronomical Society, in consideration of which sixteen of the remaining members were elected Fellows of the R. A. S. on 1845 Jan. 13, and these, together with three Members of the Mathematical who were already Fellows of the Astronomical, were excused payment of admission fees and subscriptions.

The President announced that the Council had awarded the Society's Gold Medal to Dr. S. C. Chandler, for his researches on Variation of Latitude, on Variable Stars, and other works, and read his address setting forth the grounds for this award. The Medal was handed to Dr. Huggins, the Foreign Secretary, for transmission to Dr. Chandler.

On the motion of *Sir Erasmus Ommanney*, seconded by *Mr. Thwaites*, it was resolved that "The Report now read be received and adopted, and be printed and circulated in the usual manner, together with the Report of the Auditors and the President's Address."

The President appointed Major Kingsley Foster, Mr. George Hunt, and Mr. B. Woodd-Smith as Scrutineers of the Ballot.

The Ballot was then proceeded with, and the following gentlemen were elected as Officers of the Society for the ensuing year:—

President: Dr. A. A. Common. *Vice-Presidents*: Capt. W. de W. Abney, W. H. M. Christie (Astronomer Royal), Prof. G. H. Darwin, Dr. Isaac Roberts. *Treasurer*: E. B. Knobel. *Secretaries*: E. W. Maunder, Prof. H. H. Turner. *Foreign Secretary*: Dr. William Huggins. *Council*: Sir R. S. Ball, Dr. A. M. W. Downing, Dr. J. W. L. Glaisher, Capt. E. H. Hills, R.E., Frank McClean, W. H. Maw, H. F. Newall, Capt. William Noble, G. M. Seabroke, Rev. Walter Sidgreaves, E. J. Stone, Dr. G. Johnstone Stoney.

Col. Burton-Brown proposed, and the *Rev. J. D. Parker* seconded, that "the thanks of the Meeting be given to the Vice-Presidents and other members of the Council who now retire, for their services in promoting the objects of the Society."

The motion was carried unanimously.

On the motion of *Capt. Hills*, *Mr. Dyson* seconding, a vote of thanks was accorded to the Auditors of the Treasurer's accounts and to the Scrutineers of the Ballot.

The following gentlemen were elected Fellows of the Society:—

Cyril E. Ashford, M.A., The School, Harrow; *Frank Arthur Bellamy*, University Observatory, Oxford; *Thomas Folkes Claxton*, Royal Alfred Observatory, Mauritius; *Philip H. Cowell*, M.A., Trinity College, Cambridge; *Robert Fermor Rendell*, B.A., The Glen, Blackheath Hill, S.E.; *George Albert Smith*, St. Ann's Gardens, Brighton; *Charles Albert Taylor*, 33 Argyle Street, Argyle Square, W.C.

The following Candidates were proposed for election as Fellows of the Society.:—

William Anderson, Gentleman, Ballee House, Ballymena, Co. Antrim, Ireland (proposed by A. A. Rambaut).

Thomas Frederick Furber, Chief Computer, Trigonometrical Survey of N. S. Wales, Sydney, Australia (proposed by R. T. A. Innes).

Frank L. Grant, M.A., 58 Kelvingrove Street, Glasgow (proposed by L. Becker).

Edward Ayearst Reeves, Assistant, Royal Geographical Society, 24 Clyde Road, Wallington, Surrey (proposed by John Coles).

George Frederick Herbert Smith, B.A., Scholar of New College, Oxford (proposed by H. H. Turner).

T. M. Teed, C.E., F.R.C.S., 188 Camberwell Grove, Denmark Hill (proposed by John Coles).

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE third ordinary meeting of the Association was held at University College, Gower Street, on January 29, *Mr. E. Walter Maunder*, President, in the Chair.

Seven new members were elected, and the names of fourteen candidates for membership were read and suspended.

Dr. Downing announced that it had been arranged that the Eclipse party should go by Messrs. Gaze and Sons' steamer, the 'Norse King.' The Committee were anxious to learn as soon as possible what each member of the party proposed to do, and what instrument he or she would take out for observing the eclipse.

A paper on "Eclipse Photography," by *Mr. Alfred Brothers*, was read by the *Secretary*, strongly supporting the suggestion of the President in his annual address, that some members at least should try the old collodion wet-plate process for photographing the corona. He urged that, notwithstanding the undoubted advantages of the gelatine dry-plate, the special beauty of the results obtained by the older process made it well worth a trial.

Capt. Noble drew attention to the very ingenious invention of Mr. Burckhalter, of the Chabot Observatory, California, for getting over the difficulty of the difference of exposure required for the different parts of the corona. The apparatus consisted of a cam to be rotated in front of the plate, whose shape was such that it might be made to regulate the time of exposure given to different regions from the Sun's limb right out as far as the corona was visible at all. Of course they could photograph the corona in sections, and that should be done, but he thought Mr. Burckhalter's invention was one of the most ingenious he had ever seen, and was well worth trying.

Mr. Hardy, as an old photographer, offered to instruct any member who would call on him in the wet-plate process.

Mr. Kennedy remarked that it was not necessary to use the wet plates in order to secure the advantages of the collodion process, and recommended the collodion bromide dry-plate.

Capt. Noble explained that the cam he had spoken of was a double one in the shape of a divided heart. It was carried on a thin arbor passing through the plate and rotated by clockwork placed behind the plate.

Mr. G. M. Seabroke considered that the difficulties of the wet-plate process had been very much exaggerated. *Mr. Wesley* feared that the collodion bromide plates would be found too slow. *Mr. Adams* suggested that one or two of the Eclipse party should try to catch the outer corona by cutting off both the limb and inner corona by an opaque disc.

The President agreed with several of the previous speakers in thinking that the difficulties of the wet process were often greatly exaggerated. He also confirmed what Mr. Wesley had said as to the extreme beauty of the collodion photographs of the Corona.

Mr. Petrie read a note by *Mr. A. C. D. Crommelin* on "An Easy Method of obtaining an Equatorial Mounting for the Eclipse Expedition of August 1896." The writer pointed out that as the observing station would only be 20° from the North Pole, an inclination of an ordinary altazimuth tripod through an angle of 20° from the vertical would at once convert it into an equatorial. The tripod might be sunk into the ground and held in position by a strong wooden prop.

Dr. Downing remarked that Mr. Crommelin's paper had raised a very important matter. Probably most of the telescopes taken out would be mounted with altitude and azimuth motion, and it would be absolutely necessary to leave the stands out as fixtures, but he had no doubt that arrangements could be made to do this with safety.

The President said that, remembering that Jupiter would probably be largely used as a guiding star, it might be worth while to use a fairly high power and examine the surface of the planet for any trace of the coronal streamers upon it. He did not think it likely that anything would be seen, but it was at least worth while to look out for anything abnormal in the appearance of Jupiter. The President added that as the light of the Corona and the full Moon were fairly comparable, he would be glad if some members would try the experiment of photographing some simple object, say a newspaper lighted by the full Moon, with exposures varying from 45 seconds to 6 minutes. If the photographs were successful with an exposure of 1½ minute, they would know that they had a fair chance of obtaining a photograph from the coronal light. If a few members would try the experiment, some data would be collected as to the amount of exposure that would be required.

Mr. Joseph Lunt read a paper on the "Photographic Spectrum of Helium." After giving an account of the discovery of Argon and Helium, a number of spectrographs were thrown on the screen and described.

A paper by *Dr. T. Steele Sheldon*, entitled "Photography of the Milky Way," was then read, illustrated by an interesting series of lantern-slides of photographs of the galaxy. The writer explained that, although detail was by no means wanting, the object he had in view was to present a broad photographic view comparable to the naked-eye observations of Boeddicker and Easton.

Papers were read by the *Secretary* from *Herr Leo Brenner*, "On Recent Variation of the Latitude of the Jovian Belts," and by the *Rev. W. R. Waugh*, "On the Latitude of the Jovian Belts." Herr Brenner's paper drew attention to recent changes in the latitude of the belts, indicating an approach of the two equatorial belts, finally ending possibly in the formation of a single central belt, such as Jupiter showed some 25 years ago. Mr. Waugh's paper was devoted to the defence of the accuracy and value of the drawings of the Members of the Jupiter Section.

Mr. Hardy exhibited a photograph of the model of Mare Crisium, which he had shown at a previous meeting.

Several papers were held over for want of time.

ROYAL METEOROLOGICAL SOCIETY.

The monthly Meeting of this Society was held on Wednesday evening, Feb. 19, at the Institution of Civil Engineers, Westminster, *Mr. Edward Mawley, F.R.H.S.*, President, in the Chair.

The Report on the Phenological Observations for 1895 was presented by *Mr. Mawley*, in which it was shown that, owing to the great frost at the beginning of the year, all the first spring flowers made their appearance very late, and it was not until the middle of June that plants began to come into blossom in advance of their usual time. During July the dates recorded were, as a rule, exceptionally early. The yield of all the farm crops except potatoes was exceedingly poor. Pears and plums yielded badly, but there was a splendid crop of apples and also of all the small fruits. As regards vegetation generally, seldom has a year ended under conditions as favourable for the one succeeding it.

Mr. R. H. Scott, F.R.S., read a paper on the recent unusually high barometer readings in the British Isles, in which he stated that the Daily Weather Chart for 6 P.M. on January 8 was the first in these islands that ever showed 31 inches. The station was Stornoway, and by the next morning all over the northern portions of Great Britain and Ireland the barometers were above 31 inches. The highest reading of all was 31·119 inches, photographically recorded at Glasgow at 9 A.M. on the 9th. The barometric pressure then gave way, and the region of highest readings moved southwards along our west coast, and finally left the south of Ireland on the 15th. Weather throughout the period was mild, an unusual thing with a very high barometer. At the end of the month a second anti-cyclone spread over the country, when the barometer rose to 30·96 inches at Cork. Reference was made to previous excessively high barometer readings in England and in Siberia, and it was stated that a reading of 31·62 inches at Barncoul in Siberia, in 1877, was probably the highest ever observed.

Mr. R. Inwards, F.R.A.S., read a paper on "Turner's Representations of Lightning," which he considered to be true to nature, and demonstrated the same by placing an actual example of Turner's work side by side with a photograph of a real flash of lightning.

Large versus *Small Telescopes and the Spots on Saturn.*

As the questions of the relative efficiency of large and small telescopes for planetary work, and the visibility of the spots on Saturn, have been raised at the January Meeting of the R. A. S., according to the report in the February number of the 'Observatory,' as well as elsewhere, and as my name was mentioned in connection with the latter of these subjects, it may not be considered out of place if I set down my personal views on these subjects. There would appear to be some misconception both as to the nature of the spots on Saturn and as the requisites for their satisfactory observation.

First as to the relative efficiency of large and small telescopes, I have never had much doubt as to the superiority of the large instruments, at any rate for most objects, ever since Prof. Keeler's statement in 'Publications of the Astr. Soc. of the Pacific,' Vol. ii. p. 286, to the effect that he had always found the 36-in. Lick refractor superior to the 12-in. and 6-in. refractors, when used upon Jupiter. Professor Barnard, it appears, fully confirms this superiority, and in fact the users of the big telescopes are almost unanimous on this point. This question may now, therefore, be considered as settled*.

But it seems to me very much open to question whether this superiority is so great, that an observer employing the large telescope must necessarily see more than another observer using a small one, above all where the class of object is of a kind requiring a specially trained sight, and the latter observer has given his sight just such a severe course of training as may be necessary in order to render it specially sensitive for the purpose.

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* It is, however, of course, possible that amongst the hundreds of small telescopes now in use there may be a few of such superlative excellence, as regards the dealing with planetary details, as to reduce the superiority of the big instruments to a vanishing point.

The spots on Saturn are characterized by three things:—(1) considerable size, (2) faintness, (3) extreme indefiniteness. Details of this description must be just those in which the superiority of the large instrument would be least marked. In fact, I cannot imagine in what manner any such superiority can here arise, and it would appear not to be universal, since we find Mr. Lowell, in comparing a 6-in. and 18-in. apertures, stating that the dark and light markings were more contrasted with the small aperture than with the large one.

On the other hand, markings having the characteristics stated above are precisely the kind the seeing of which depends above all upon a specially trained sight—the point being the detection of very slight contrasts in indefinite objects of considerable size. And if I have been so successful in observing spots on Saturn which have eluded the keen eye of Prof. Barnard, it is only because my sight, perhaps originally sensitive to slight contrasts, has been subjected to an exceptionally severe course of training, specially adapted for the detection of such markings as those in question, whereby it has been rendered extremely sensitive.

For most objects, it is hardly necessary to state, the advantage would be all the other way. Thus, as regards nebulæ, or in comet work, I have no doubt that Prof. Barnard would be able to see more with 6-in. aperture than I could with 12-in. My sight is also bad for the detection of faint points of light near a bright planet, so that I could no more think of emulating the greatest feat of the discoverer of satellite V. of Jupiter than I could of flying.

In describing the appearance of the spots on Saturn, I have made use of certain abbreviations, such as S=small, vS=very small, &c. &c. These descriptions have been wrongly understood by some as implying that a spot, for instance, called vS must really be a very small object. These terms have, however, been used in a relative rather than in an absolute sense. For a number of years past I have made use of a definite scale for describing the size of the spots upon Jupiter, and when Saturn became the object of observations, the same scale was made use of for this planet. Actually, as stated in the 'Monthly Notices,' Vol. liv. p. 309, the bright equatorial spots average about 2″ in diameter, or perhaps a little less. The dark spots on the broad double belt in the northern hemisphere are, on the average, no smaller than the bright spots, and have sometimes appeared much larger, so as to be as much as 4″ long by 2″ to 3″ broad. On the other hand, some spots have appeared very minute.

The spots on Saturn have been described by some of those unable to see them as "illusory." It is, however, simply impossible that observations of illusory objects made and reduced in the manner described in the 'Monthly Notices,' Vol. liv. pp. 298, 299, could show the remarkable relationships and peculiarities which I have pointed out. Besides which the independent observations of various other observers—namely, Brenner at Lussinpiccolo, G. L. Brown at Stirling, Henderson at Liverpool, Kempthorne at Wellington College, McEwen at Glasgow, and Quénisset at Juvisy—agree quite satisfactorily with my own observations and with those of each other. Many other observers besides the above have also seen the spots, though without determining their positions *.

Again, it has been objected to some of my observations of these spots, that they were made when Saturn was nearing conjunction with the Sun. This was in 1891, when a few obsevations were made as late as the middle of July. Conjunction with the Sun occurred in this year on Sept. 13, so that the last observations were still made as much as two months before conjunction. It is almost needless to point out that with a planet so distant as Saturn, the diminution in its apparent size when nearing conjunction is of little importance, especially so far as the observation of objects having an average apparent diameter of 2″ about the time of opposition is concerned. And as to the objection of the low altitude of the planet at this time; according to my experience definition is usually much better about the time of sunset and for about an hour thereafter than at other times. This is at any rate true for the south of England. It was at such times that the observations in question were made, and it is sometimes possible under such circumstances to get very fair definition even when a planet is quite close to the horizon.

In conclusion, I would invite all those who are in the habit of observing the physical aspect of the planets to pay special attention to Saturn during the coming spring. The success of the observers named above would seem to show that many observers possessed of a keen sight and a good telescope would be able to see at any rate the plainer of the spots under favourable circumstances, and with sufficient plainness to determine their position. It would be well to bear in mind also the experience of Herr Brenner, who finds that the spots are best seen with a low power and that they disappear with high powers. I have myself seen an equatorial spot shining out with almost stellar brightness with a power of 140. With higher powers this spot, although still plain, lost this peculiar stellar brilliancy. Its position could, however, be determined best with the higher powers, on account of the larger size of the image. A. Stanley Williams.

West Brighton, 1896, Feb. 17.

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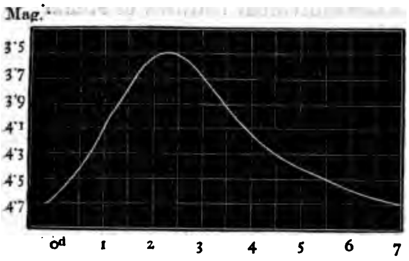
* In an interesting paper on the relative powers of large and small telescopes, published in 'Nature' for July 4, 1895, Mr. Denning is rather inclined to disparage the value of corroborative evidence by a few observers, stating that "It is a fact that, if any new feature on a planet, or an unknown companion to a star were confidently announced, a few of the many observers who looked for it would certainly assert they could see it though not really existing." However true this might be in respect of a mere assertion by an observer that he had seen the spots on Saturn, it can obviously have no bearing at all where the observers have carefully determined the positions of the spots stated to have been seen by them, and such positions are afterwards found to accord with the positions determined by other observers.

Five Short-Period Variables.

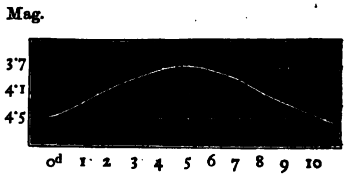
The discovery by M. Bélopolsky in 1894 that δ Cephei is a binary star revolving in the identical period of its light-change, made it antecedently probable that other quick and punctual variables would be found to possess the same significant character.

Its recent detection, accordingly, by Mr. J. Norman Lockyer, in four additional stars, excites deep interest, but little surprise. The details of his investigation are not indeed at present available to the general public; so that we are not in a position to form an independent judgment as to how far they warrant his conclusions; nor have these as yet been verified by other observers. Presumably, however, they eventually will be; and, at any rate, it is worth while to consider briefly the points of agreement and difference between such peculiar and still enigmatical objects.

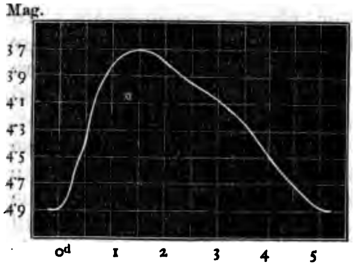
Among these, the manner of their variability is the most important, and can be taken in by a glance at the accompanying little diagrams, which pretend to no more than a general accuracy. It



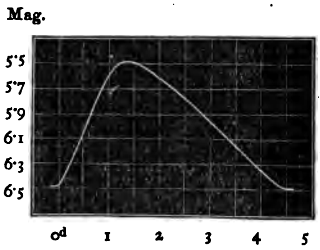
Light-Curve of η Aquilæ.



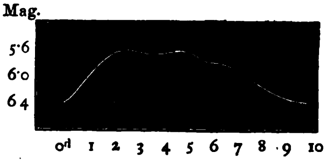
Light-Curve of ζ Geminorum.



Light-Curve of δ Cephei.



Light-Curve of T Vulpeculæ.



Light-Curve of S Sagittæ.

will be remarked that four out of the five, *i. e.* δ Cephei, η Aquilæ, S Sagittæ, and T Vulpeculæ, agree in rising towards maximum much more rapidly than they descend from it; and this peculiarity is shared by the vast majority of variable stars, whether of short or of long period, including our Sun, if we agree to regard the development of spots as a symptom of disturbance corresponding to stellar increase of brightness. An exception to this rule is furnished by ζ Geminorum, the fifth of the group of variables we are just now considering. Its light-curve is almost symmetrical; and it will be remembered that the quadruple phases of β Lyræ are strictly equal in point of time, notwithstanding the rapid physical changes indicated by its spectrum.

S Sagittæ, too, one of Mr. Lockyer's stars, shows two maxima, besides an abortive third; but they are irregularly situated on the curve, and are separated by only a trifling depression, representing a failure of light to the extent of no more than one-fifth of a magnitude. Their succession has been watched during six years by Mr. Paul S. Yendell ('Astronomical Journal,' No. 321); and it is only by vigilance like his that the individual features of stellar variability can be brought into notice.

The spectra of all these stars belong generically to the solar type; bnt with specific differences. They seem, however, to have impressed themselves feebly on the Harvard College plates, the notes to the Draper Catalogue indicating considerable uncertainty as to their proper classification. The one remarkable trait common to all is the shifting of their dark lines of absorption to and fro with the waxing and waning of each star's light. They do not otherwise alter, except as regards the intensity of the *continuous* light dispersed to form them; but no emergences of bright lines or effacement of dusky ones has been recorded in any of these five stars. The swinging lines, moreover, always remain single. In other words, the binary systems, to the existence of which they indubitably point, are composed, not of two suns, such as are combined in ζ Ursæ Majoris and β Capellæ, but of a Sun attended by a totally obscure or imperfectly luminous satellite. It is not, however, by the interposition of such bodies that these stars lose and gain lustre; such an explanation of continuously progressive light-change is, on the face of it, most improbable, and in the case of δ Cephei may safely be said not to occur. Much still remains to be investigated, much to be discovered, regarding these perplexing phenomena. A. M. Clerke.

The Rotation of Venus.

It may at first sight seem a little remarkable that there should be any great uncertainty in the received value of such an astronomical constant as the period of rotation of Venus, our comparatively near neighbour. It nevertheless is the fact that it still remains a matter for settlement whether the planet rotates on its axis in about the same time as our Earth, or in about the same time as Venus describes its orbit about the Sun. This uncertainty is no doubt to be accounted for by the difficult nature of the observations on which the determination of the value depends, or possibly to the uncertainty of the objects of observation themselves, which may have been actual topographical detail, but may in some cases have been simply shifting clouds.

The first attempt at a value of this period was made by J. D. Cassini, who, from observations of surface-markings in 1666–67, concluded that Venus rotated in *about* 23 days. He, however, gave this result with some doubt as to its accuracy, because, as he said, the observations were difficult on account of the diffused appearance of the spots. The next value was found by Bianchini in 1726, who from observations of dark shades, seen always along the terminator, and never in the middle of the illuminated part of the disc, deduced a period of 24 days 8 hours. But, strange to say, the younger Cassini, comparing these observations of Bianchini's with those of his father, showed that the two sets of observations were consistent with a period of 23 hours 20 minutes.

This last-named period, supported by Schroter (1788–93), who determined from his own observations a period of $23^h\ 21^m$, and by De Vico (1839–41), who, combining his observations with some of Bianchini, concluded that the time of rotation was some 22 seconds longer, seems to have held its ground until Schiaparelli in 1890 published an investigation, in the course of which he said that "from Jacques Cassini to De Vico the period $23^h\ 20^m$ has been maintained by a series of illogical and illusory conclusions." This investigation depended on observations made with the 8-inch refractor of Milan, between 1877 November 5 and 1878 February 7, of two small and very bright spots seen close to the southern cusp. These were seen fixed in one position for about a month, no change being detected in their position relatively to the terminator during a day's observation. The appearance of these spots was confirmed by Holden, Niesten, and Trouvelot, and from this Schiaparelli concluded that the period could not be about 23 hours, but that the Milan observations could be reconciled only by a period of between 6 and 9 months, and he made the suggestion that the period was the same as that of the planet's sidereal revolution about the Sun—that is, that the same point of Venus is continually turned towards the Sun, from which it would follow that markings are always seen in the same position relatively to the terminator.

M. Niesten almost immediately contested the truth of this result, on the ground that he and M. Stuyvaert both believed they had seen rapid displacements relatively to the terminator of both bright and dark spots. M. Trouvelot also, from an extensive series of observations of Venus made between 1876 and 1892, published in the 'Journal of the Société Astronomique de France,' was inclined to think that the rotation period did not differ much from 24 hours, and so the matter rested until quite recently, when considerable interest has been revived on this disputed point.

Herr Leo Brenner, of Lussinpiccolo, from observations extending over several months in the summer and autumn of 1895, and made during several consecutive hours of the day, deduced a rotation period of $23^h\ 57^m\ 7^s{\cdot}5459$, which *he says he has proved* cannot differ from the real rotation period by one second. Herr Brenner will perhaps pardon us for thinking the fourth decimal place an unnecessary refinement. Most people would have been satisfied to know the nearest second with certainty. In 'Ast. Nach.' No. 3329, M. Mascari published a series of observations of the planet, with drawings, made during 1892, 1893, 1895 at Catania, from which he did not actually deduce a numerical value of the period, but, as the markings relative to the illuminated limb at similar phases are remarkably alike in position, go far to support Schiaparelli's view of a period of rotation coinciding with that of revolution. The fact of a short period of rotation is also contested by Prof. Cerulli, of Teramo, who, in the same number of the 'Nachrichten,' publishes observations of Venus made for several hours continuously on various days in November and December last, when he could detect no diurnal change of position of the markings. Prof. Tacchini has also lately published as a deduction from observations made during the latter half of 1895, when the planet was observed for long periods throughout the day, during which the same features were seen to remain in the same position, a rotation period of 224·7 days; but, on the other hand, in 'Ast. Nach.' No. 3332, there are some drawings of Venus made by M. W. Villiger, of Munich, from observations during the same period, which lead him to consider a short period not differing much from 24 hours as the true one; and it may be noticed in passing that the white spots near the cusps which were the principal objects of Schiaparelli's observations are conspicuous objects in M. Villiger's drawings. And so the matter rests; much evidence has been lately accumulated, but the definite solution of the problem is still distant, and can only be attempted by a comparison, perhaps invidious, of the relative merits of the observations.

Σ 1074 *and* Σ 1500.

THERE are a number of stars which from some cause do not get much observed by double-star observers. The two Struve stars here noted have received but scanty attention, and yet they are of interest by reason that their motion is very probably binary.

Both stars have the same characteristics as regards motion, and are hence treated of together; in fact, the pairs are almost alike;

whether we consider the magnitude of the components, the form of their apparent orbits, or the place in the orbit.

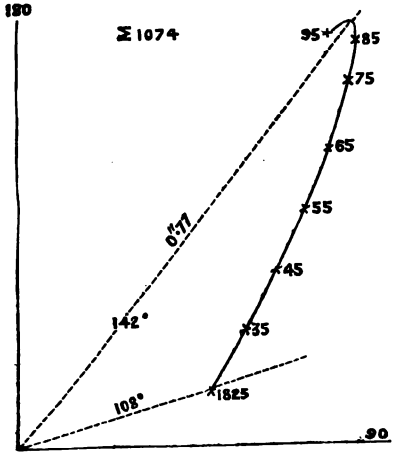
The observations, too, are in each case rather discordant, although when carefully plotted down they are sufficient to show the nature of motion, and that both have apparently just passed the apse, so that the distances may be expected to decrease, and careful measures now will decide the question and make it possible to compute an approximate orbit. All published observations are included in the following :—

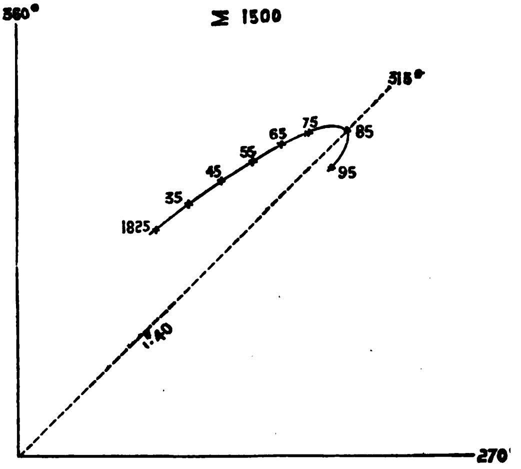
Σ 1074.

Year.	Pos.-ang.	Dist.	Year.	Pos.-ang.	Dist.
	°	"		°	"
1825·2 ……	110·6	0·4	1874·1 ……	136·6	0·89
31·5 ……	115·4	·52	78·1 ……	138·1	·66
44·2 ……	127·8	·45	87·2 ……	141·1	·78
52·7 ……	136·3	·51	89·1 ……	141·8	·83
59·2 ……	141·4	·5	92·2 ……	143·1	·75
68·0 ……	137·9	·58	95·2 ……	137·4	·58

Σ 1500.

Year.	Pos.-ang.	Dist.	Year.	Pos.-ang.	Dist.
	°	"		°	"
1825·2 ……	330·9	1·07	1867·3 ……	315·4	1·44
32·3 ……	322·3	0·98	71·6 ……	314·8	·46
40·3 ……	320·0	1·13	74·2 ……	314·1	·42
41·7 ……	320·0	0·99	75·5 ……	314·9	·44
43·8 ……	322·6	1·05	80·2 ……	313·8	·42
56·3 ……	318·3	1·05	86·4 ……	314·3	·38
60·3 ……	315·8	1·15	93·3 ……	312·4	·28
64·2 ……	319·5	1·2			





It will be seen that the apparent orbits are much elongated, and consequently the variation in angle is, at present, very small.

The magnitudes and the position for 1900 are—

	R.A.	N.P.D.	Magnitude.
Σ 1074	$7^h\ 15^m\ 23^s$	89° 25′	7·8 and 8·2
Σ 1500	10 54 56	93 57	7·6 „ 8·2

The small companion to Σ 1074 is β 577, in position 106° and distance 14″.
THOMAS LEWIS.

Selenographical Notes.

MT. ARGAEUS.—Among the isolated mountain-masses of the Moon, this object is one of the most remarkable and beautiful both as regards its situation and surroundings, as well as by reason of the peculiarity of its shape and the general steepness of its flanks.

Placed at the south-western corner of the Mare Serenitatis, it appears above the normal level of the surface a few miles north-east of the ring-plain Vitruvius, and, continuing to rise at a strikingly uniform gradient for a distance of more than 30 miles, culminates at a point some 8000 feet above the Mare—to the surface of which it sinks in a precipice, presenting a perpendicular face towards the north-east. When viewed under a moderately high angle of morning illumination, its form resembles the head of a javelin, the point being at the southern extremity. It is, in fact, a wedge-shaped mass, which, though pointed at the southern end, rapidly attains its maximum width of about 7 or 8 miles, and then, gradually becoming narrower, dwindles to a ledge of less than half this width at its northern end, where it overlooks the vast expanse of the Mare at the summit of the precipice just mentioned. Its axis ranges roughly from S.W. to N.E., and its sides are nearly as steep as the cliff at its northern termination. At one place, about midway, it is traversed by a deep valley or gorge, which apparently cuts down nearly to its base, allowing the rays of the Sun to shine through it, and hence produce a narrow band of light in the midst of the shadow of the mountain. On the broad but low plateau near its southern end is a shallow circular depression, fully six miles in diameter, with a floor only slightly darker than the bright surface in which it is sunk. It is only traceable under a low angle of illumination, when its walls are seen to cast a narrow band of shade. Neither Schmidt or Mädler show anything of this, and Neison has only a very small craterlet near the site, which can hardly represent a feature of such a considerable area. Abutting on the curved south-east side of the javelin point lies a much more conspicuous crater of about the same size, and of considerable depth, for it holds shadow when sunrise is well advanced. All the maps show this prominently. Though close to the mountain-mass, it is not connected with it; a very narrow valley, concentric with the crater, intervenes.

Between 9^h 30^m and 8^h 30^m on January 20, a fine view of this region was obtained under very fair conditions. With a power of 284 I remarked what appeared at times of best seeing a minute crater at the extreme northern end of the mountain, that is at its summit. I do not find this recorded in any of the maps. At first I took it to be a small peak, but, if present, such an object would be revealed in the shadow at this phase, yet no projection interrupts the remarkable uniformity of outline of the shadow of Mt. Argaeus, which is as straight as the edge of a "set square," which it resembles in shape. Hence what was undoubtedly noted must be a hollow of some kind. The great cleft running from Dawes, past the northern foot of the precipice, towards Littrow and the rugged highlands between Römer and Le Monnier, was an easy object, as was also the little crater through which it passes, at the base of Mt. Argaeus. East of the somewhat dusky crater, Littrow B, which lies on the western slope of a broad, low, longitudinal surface-swelling, I noted two contiguous and very remarkable obscure rings, each about 12 miles in diameter. Both are nearly circular, and their inconspicuous rims appear to be continuous, except in the case of the more southerly, which is scarcely traceable on the eastern side. South-west of, and immediately adjoining, the conspicuous crater associated with the southern end of Mt. Argaeus stands a bright crescent-shaped rock, which seems to be the relic of another crater, which, when complete, was of about the same size. Its south-eastern flank is wanting. It is prominently shown by Schmidt, and, curiously enough, Schröter (Sel. Top. Frag. tab. xi. fig. 2) draws it as an *entire dusky* ring, contrasting strongly with the prominent crater on the east of it.

Most observers are familiar with the two parallel rows of isolated rocks, outliers of the Taurus range, which are situated between Mt. Argaeus and the southern end of these mountains. The more westerly are four in number, terminating a few miles north-west of the ring-plain Vitruvius, while there are only three in the other row, which are smaller and somewhat less lofty. All of them appear to rise sheer from the surface of the Mare, as if they had been pushed through it from below when it was in a plastic condition, though it is more probable that they are of more ancient date, and that the "sea" has consolidated round their bases. Anyhow, both these island mountains and the neighbouring Mare are beautiful objects under every phase, the latter being specially noteworthy for its variegated tone and the subtle distribution and intermingling of light and dark tones, of which no photograph, however excellent, gives an idea.

Beaumont House, Shakespeare Road,
Bedford, 1896, Feb. 19.

T. GWYN ELGER.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

"Longitude Harrison" and his Brother.

GENTLEMEN,—

As every circumstance connected with this extraordinary genius naturally commends itself not only to horologists but to astronomers also, may I draw attention to some particulars which do not appear in any biographical notice which I have seen, from presumably the earliest—that in the 'Annual Register' for the year 1777, pp. 24, 25—to the latest and fullest—that included in Dr. S. Smiles' 'Men of Invention and Discovery'? In all these, Henry Harrison, his father, who was a carpenter and joiner and handy-man generally, in the service of Sir Rowland Wynne, the owner of the Nostel Priory estate, situated about four miles from Pontefract, Yorkshire, is simply mentioned incidentally, and his only brother, James, born in 1697 (four years after him), not at all. In 'The Church Bells of Lincolnshire,' by the late Mr. T. North, F.S.A. (Leicester, 1882), will be found a pedigree of the Harrisons, extending from the above-mentioned Henry Harrison, of Foulby, in the parish of Wragby, near Pontefract, down to the latest representative of the family, viz. James Harrison of Hull (watch and clockmaker), who died about 1870, and was a great-grandson of James. This pedigree is founded on the late Mr. Heseldine's MS. collection, corrected and augmented from the parish registers of Wragby and Barrow-on-Humber, to which place the Harrisons removed about the year 1697, when John, of Longitude fame, was about four years old, and where the father was parish-clerk 31 years. The latter, however, seems to have retained his connection with the Wynne estate as carpenter, &c., his sons ultimately assisting him in the business, and also undertaking land-surveying and the repair of clocks and watches. Mr. North remarks:—"They were ingenious men, and set to work attempting to construct an instrument for determining the longitude at sea, for which a large reward (£20,000) was then offered by the Government. The instrument was, after several trials and improvements, completed, as is generally supposed, by John Harrison, the elder brother; but the popular impression in their own neighbourhood was that James was the greater genius of the two, and from his conception the time-keeper was modelled and completed, but that being the most careless and easy of the two in disposition and habits, he allowed his brother to take the instrument up to London, where, as was anticipated by their neighbours, he introduced it as his own invention and obtained the full credit for it himself. However that may have been, it is certain that John Harrison obtained all the renown, and, after much trouble, the promised reward; and that the only share James or his family received was the free grant to them of the house in which they resided at Barrow." One would like to know, if possible, what historical value may be attached to the foregoing statement. "Popular impressions" are certainly not to be altogether ignored when they relate to such a man as James Harrison, who lived nearly 70 years in Barrow, and was undoubtedly one whose attainments and mechanical skill (far above the average) were indelibly impressed upon his contemporaries, the fame of which is still surviving in the neighbourhood. He was the first of the family who adopted bell-founding as a business, though his brother John, according to Smiles, interested himself sufficiently in bells to undertake the tuning of those of the parish-church of Hull; and the direct descendants of both brothers became distinguished as the founders of church-bells in Lincolnshire and elsewhere. The father died in 1728. In this year John came to London with the drawings of a machine for determining the longitude at sea, and, after an interview with Halley and George Graham (the well-known inventor of the dead-beat escapement), he was advised to *make* his timepiece before he applied to the Board of Longitude. Seven years after this (1735) he returned to London with his *first* instrument complete. The story of two other timekeepers, and of that produced in 1758 (but not tested at sea till 1761), which practically solved the problem of the longitude, need not be further alluded to, as it is told fully and eloquently by Smiles.

More light is certainly needed before the account just quoted, so far as it relates to James Harrison's association with his brother's inventions (including, besides the time-keepers, the gridiron-pendulum and the going-fusee), can be accepted; and my object in this communication is to elicit information from others who, it may be, have access to reliable documentary evidence which will supply the deficiency. Yours faithfully,

Bedford, 1896, Feb. 13. T. Gwyn Elger.

Eclipses and Chronology.

Gentlemen,—

Although unable to assent to all Prof. Stockwell's historical conclusions, I am much interested in his eclipse calculations. May I suggest to him the undertaking of one more? In his letter in the February number of the 'Observatory' he quotes a description from Plutarch's 'Morals' (Dialogue "On the Face appearing in the Orb of the Moon," c. 19) of an eclipse of the Sun, which would lead us to suppose that it was total or very nearly so, and is said to have occurred ἔναγχος, recently. Now of Plutarch, as of Ptolemy, we know absolutely nothing except what we can gather from allusions and hints dropped by himself. He is generally supposed to have been born in the reign of Claudius, about A.D. 50; but this is doubtful, and his birth may have been several years earlier. Prof. Stockwell, however, extends his eclipse-net sufficiently wide, and states that no eclipse corresponding to Plutarch's description occurred between A.D. 50 and A.D. 130, except one on the 3rd of September in A.D. 118. It is uncertain whether Plutarch survived the emperor Trajan, who died in A.D. 117 (the statement in Seyffert's 'Dictionary of Classical Antiquities' that he was appointed procurator of Greece by Hadrian is in all probability erroneous), but at any rate, if alive in A.D. 118, he must then have been in advanced years.

Prof. Stockwell finds that the magnitude of the eclipse of Sept. 3, A.D. 118, amounted at Chæroneia to 10½ digits. But surely an obscuration of even that amount would not, according to Plutarch's statement, make many stars visible in several parts of the sky (πολλαχόθεν). Mr. C. W. King, in his translation of the theosophical essays in the so-called 'Morals,' has a note on this passage, "April 30, A.D. 59, a notice fixing the date of this treatise." Prof. Stockwell does not refer to this eclipse, although it falls within the range embraced in his statement, and must have been a large eclipse in the south of Europe soon after midday. If he has overlooked it, perhaps he will calculate its circumstances from his data, which will no doubt be interesting. As is stated in my letter to the 'Observatory' for August 1893 (vol. xvi. p. 294), it is mentioned by Tacitus in lib. xiv. c. 12 of his 'Annals.'

Yours faithfully,

Blackheath, 1896, Feb. 7. W. T. LYNN.

Naked-eye Views of Mercury.

GENTLEMEN,—

There are certain observations which, if they exercise no influence on the progress of astronomy, yet excite the attention of amateurs and help in sustaining their interest in the science. Such observations are generally among the earliest attempted by beginners, and though in after years spectacles of the kind alluded to must lose their novelty, they seldom decline in interest. I refer to planetary conjunctions, to naked-eye views of Mercury, to observations of the Moon one or two days after the new, &c. &c.

As regards observing Mercury, the feat may be accomplished pretty often by anyone who will specially look for the planet at the evening apparitions during the first half of the year, and at the morning apparitions during the last half. Mercury was at his greatest elongation (18° 31′ E.) on January 23 last, but I only secured two naked-eye observations, viz. on Jan. 19 and 28, the intervening evenings being cloudy. On Jan. 29 I picked up the planet with the aid of a field-glass, but there was too much fog and smoke near the horizon to allow a view with the unaided eye.

To those who care to make observations of this sort, an unusually good opportunity will be afforded on May 16, when Mercury will have an elongation of 22° 2′, and on several nights near that date will set 2½ hours after the Sun. On May 14, at 9 P.M., the crescent of the new Moon (2^d $1\frac{1}{4}^h$ old) will be about 3° N.N.E. of the planet.

Yours faithfully,

Bristol, 1896, Feb 8. W. F. DENNING.

Herschel's Observations of Saturn's Ring.

GENTLEMEN,—

It is well known that, although Cassini was the first to notice a black line in the breadth of Saturn's ring, it was not until 1791 that Sir W. Herschel convinced himself that the appearances seen were due to a complete division all round, his paper describing this being read to the Royal Society on the 15th of December in that year, and forming the first in the volume for 1792. There is an amusing misprint in the said paper, at which I presume we may be permitted to indulge in a smile. "Without being in possession of the original observations of M. Cassini," says Herschel, "I cannot decide whether the black list which he saw was the same which I have observed." Observations are not often arranged in black lists, and it is obvious that "list" is here a slip or a misprint for "line." The only reason he appears to have had for doubting whether Cassini had really seen the same marking which he saw was that Lalande spoke of Cassini as having seen the ring divided into two *equal* parts. This, however, would seem to have been merely a hasty inference from his drawing. Cassini does not say that the parts were equal or unequal, and doubtless his observations were not precise enough to enable him to pronounce upon the greater width of the interior ring, though he did distinctly notice its superior brightness. It may be of interest here to quote his exact words from No. 128 of the 'Philosophical Transactions' (for 1676 Sept. 25):—

"Deinde latitudo annuli dividebatur bifariam, lineâ obscurâ apparenter Ellipticâ, re verâ circulari, quasi in duos annulos concentricos, quorum interior exteriori lucidior erat. Hanc phasim stetim post Emersionem *Saturni* è Solaribus radiis per totum annum [*i. e.* 1675] usque ad ejus Immersionem conspexi; primò quidem, Telescopio pedum 35; deinde minori, pedum 20. Ejus delineationem, utcumque rudem, properante calamo hic adjeci."

It will be noticed that he does not claim great accuracy for his drawing, from which Lalande's remark would seem to be taken.

Yours faithfully,

Blackheath, 1896, Feb. 5. W. T. LYNN.

Some Chinese Comets.

GENTLEMEN,—

In a 'New General Collection of Voyages and Travels,' London, 1747, we have the following three comets mentioned under the head of the "Description of Corea."

"Towards the end of the year (1663) a comet appeared, and after that two at once; the first was in the south-east for about two months; the other in the south-west, but their tails were opposite to each other. The Court was so much alarmed at it that the King caused the Guards to be doubled in all his ports . . . The Commonalty whenever they met the Hollanders never failed to ask what they thought of comets in their country. The answer was that they presaged some signal judgment," &c.

None of the above can well be identical with the well-known comet of 1664, which passed its perihelion a year later than the above are recorded. There is no comet mentioned in our popular catalogues between A.D. 1661 and 1664. Yours faithfully,

Melplash Vicarage, Bridport, S. J. JOHNSON.
1896, Feb. 21.

The Sun's Path in Space.

GENTLEMEN,—

The spectroscope appears to confirm the theory of the Sun's path proposed in your January Number. For, if the apparent parallactic apex of the Sun's path is deflected westward by his motion, the true apex must lie eastward of every parallactic apex, but in the same plane. Now M. Homann's spectroscopic observations (cited in Miss Clerke's 'System of the Stars,' p. 328), which are independent of visible displacement, fix the Sun's apex at R.A. 315°, D. 38°, a point 26° E. of the apex deduced from distant stars, and about 50° E. of the apex generally assumed, but still in the plane of the Milky Way.

The spectroscopic apex agrees, therefore, with the theory; and from this point, assumed to be approximately the true apex, the several points deduced from distant and nearer stars mark out in the heavens the direction and plane of the Sun's orbit.

Yours faithfully.

London, Feb. 1896. G. C. BOMPAS.

PUBLICATIONS.

UEBER DIE TOTALE SONNENFINSTERNISS AM 8/9 AUGUST 1896. Von TH. WITTRAM. (Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg, 1896, January, tom. iv. no. 1).—The writer points out that by far the greater portion of the land-track of this eclipse is on Russian territory, and expresses the hope that as many stations as possible will be occupied. The partial phase will be visible over the whole of Asiatic Russia, and he gives full details as to magnitude and times of contacts for different stations, as he considers that it may be utilized for determining longitudes. The paper is accompanied by an excellent map of the entire land portion of the track, showing the local times of beginning, totality, and ending, also the duration of totality; the magnitude of the greatest phase and the times of contacts are also indicated for the regions outside of the track of totality.

In his computations the author uses the 'Nautical Almanac' co-ordinates of the Sun and Moon; the mean semidiameter of the Sun is taken as 15′ 59″·63 (Auwers' determination); the Moon's radius is taken as 0·272535 of the Earth's equatorial radius, this being derived from Struve's discussion of the occultations observed during the lunar eclipses of 1884 and 1888. Newcomb's value of the Sun's parallax (8″·848) is used, and the Earth's compression is taken as $\frac{1}{294}$. These values give for the track across Norway a position practically coincident with that deduced from the American ephemeris, but a duration coincident with that deduced from the 'Nautical Almanac.' The track across Norway, as deduced from the 'Nautical Almanac,' is 8 or 9 miles too far south, this error being due to the neglect of second differences in the motion of the Moon.

Special computations are given for the following places, to all of which there is some ground for expecting that Russian expeditions will be sent:—(1) On the Amur River, (2) Nova Zembla, (3) Mouth of the Obi. There is also some hope that the point where the central line crosses the River Lena may be occupied. Should all these expectations be realized, there will be in the aggregate six observing parties, ranged at fairly equal intervals along the central line, and the opportunities for detecting changes in the corona will therefore be considerable. A. C. D. C.

ANNALES DE L'OBSERVATOIRE ASTRONOMIQUE DE TOKYO, Tome I. Fascicule iii.—The third instalment of the publications of the enterprising observatory attached to the Imperial University of Japan consists mainly of a description and results of the determination of the longitude of the great Transit Instrument of the observatory; the determination of the latitude was given in part 1 of this volume. This longitude was determined in 1892 by Mr. Midzuhara and Mr. H. Watanabe, who measured, by the telegraphic method, the arc of longitude connecting Tokyo with Nagasaki on five nights between May 21 and June 27, and the arc between Tokyo and Yokohama on four nights between July 29 and August 4. Nagasaki and Yokohama, it may be remembered, were two stations of the series at which longitude determinations were made by Commanders Green and Davis of the American Navy in 1881–82, so that these two arcs now determined form a circuit with the American arc Nagasaki – Yokohama.

Mr. Midzuhara was the travelling observer, and made time determinations, both at Nagasaki and Yokohama, with a small portable transit of 2½ inches aperture. Mr. Watanabe stayed in Tokyo and made time-determinations with the transit instrument of the observatory. We need not mention the circumstances of these determinations, they are given in detail in the part now before us. It may be sufficient to say that many stars were observed and the level read frequently, all with obvious care and skill, that the transits were recorded, and the signals for comparison of chronometers received on tape chronographs, and that the observations of transits were reduced by the method of least squares, after correcting for error of level. But a point which strikes us as a little remarkable is the method in which the relative personal equation has been determined and adopted. The observers were not exchanged, but Mr. Watanabe remained throughout at Tokyo, so that there was thus no elimination of personal equation; but this quantity was determined after the observations on six nights between 1892, Aug. 18, and 1893, March 9. On the first two nights, Aug. 18 and 21, both observers used the great Transit Instrument, the one observing stars on the first six wires, the other then observing the same stars on the last six wires. The mean value of the relative P.E. of these two nights is $+0^{\mathrm{s}}\cdot266$. On the other four nights relative P.E. was found by the observers making time-determinations side by side, each using the instrument he had used in the actual longitude. The relative P.E. found from the mean of the two nights Oct. 25 and Nov. 2 was $+0^{\mathrm{s}}\cdot301$, and from the two nights 1893 March 2 and 4, $+0^{\mathrm{s}}\cdot437$, and from these results it is argued that the personal equation progressively increased, and values were extrapolated for application to the actually determined lengths of the arcs. Thus to the arc determined in 1892, May and June, relative personal equation $+0^{\mathrm{s}}\cdot181$ was applied, and to the arc determined in 1892, July and August, $+0^{\mathrm{s}}\cdot238$. Knowing how the personal equation of an observer may vary with the instrument he uses, we should have been inclined to altogether reject the observations made by Mr. Midzuhara with the great Transit Instrument, and possibly relied altogether on the observations of Oct. 25 and Nov. 2.

The values found from these arcs (Nagasaki – Tokyo $= 39^{\mathrm{m}}\ 29^{\mathrm{s}}\cdot094$ and Yokohama – Tokyo $= 21^{\mathrm{s}}\cdot128$) have been combined by Prof. Terao and Mr. Midzuhara with the series of longitudes made by the American officers above mentioned, and with the longitudes of Madras and of Vladivostock, which were referred to in our number of October last, and they thus find the longitude of the observatory to be $9^{\mathrm{h}}\ 18^{\mathrm{m}}\ 58^{\mathrm{s}}\cdot222 \pm 0^{\mathrm{s}}\cdot114$ East of Greenwich.

The remaining section of the part gives the observations made with the meridian circle of the difference of declination of Mars and comparison stars at the opposition of 1892 and results, a work which was carried out entirely in accordance with the rules contained in the circular issued by the United States Naval Observatory. Unfortunately, the scheme of the work seems to have been interfered with, first by the illness of Prof. Terao, the Director of the observatory, who was to have been the principal observer, and then by the temporary illness of Mr. Kimura, in whose name the work is published, and also by very bad weather which prevailed at the most important period. Nevertheless, observations were made on 37 nights, comparisons being made generally with eight comparison stars, no doubt a useful contribution to any investigation of the planet's elements.

REDUCTION OF THE GREENWICH METEOROLOGICAL OBSERVATIONS, PART III *.—We are pleased to welcome the appearance of this work. It embraces a complete reduction of the observations and records of temperature of the air at Greenwich for the 50 years 1841–90 as discussed under the direction of the Astronomer Royal, and forms a valuable addition to the elaborate series of reductions which have already been issued from the Royal Observatory. The preparation of this work, involving the collection of results deduced from the reduction of nearly half a million separate readings, has engrossed much of the time of Mr. Ellis not only during his latter years of service, but also since his retirement, and the completion of the work forms a fitting close to his long and laborious official career.

It can scarcely be possible to over-estimate the value of this collection of tables to the statistician. We have here in a handy form an authoritative standard for reference of the temperature—highest, lowest, and mean—for every day of the year through a lengthened period of time, and in succeeding tables useful particulars are given relating to means and extremes, dates of high and low temperatures, dates of early and late frosts, &c. &c. Culling a few examples here and there, we find that in 1855 (the year of the severe Crimean winter) there were 93 days on which the temperature fell below 32°, but that this number was exceeded in 1879—the number in that year amounting to 95. In 1872 the number of frosty days amounted to 17 only. The latest date on which a temperature of 32° or below was registered in the period was May 24 in the year 1867—scarcely "Queen's weather." In another year, 1885, an autumnal temperature below 32° was registered as early as September 27. The highest temperature recorded during the series was 97°·1 on 1881 July 15, and the lowest 4°·0 on 1841 January 9, giving an extreme range of 93°.

The greatest range of temperature in any year was experienced in 1881, amounting to 84°·4, whilst the least annual range occurred in the succeeding year (1882) and amounted to 58°·8. The earliest date on which the year's maximum took place was May 6 in 1862, when a temperature of 81°·5 was recorded, and this was the only temperature in that year exceeding 80°. In 1860 (a very cold year) the highest temperature recorded in the year was 76°·5, on

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* Reduction of the Greenwich Meteorological Observations.—Part III. Temperature of the Air as determined from the observations and records of the fifty years 1841 to 1890, made at the Royal Observatory, Greenwich, now collected and discussed under the direction of W. H. M. Christie, M.A., F.R.S., Astronomer Royal. London, 1895.

May 23. Another view of maximum temperatures is presented in the list of days (eleven in number) on which the temperature never reached 25°, the most remarkable day having been January 8, 1841, on which the maximum temperature is stated to have been 16°·7! Turning now to warmer days, we find that in the 50 years there have been 191 days on which the temperature continued throughout above 60°, and that 150 of these days are claimed by the months of July and August.

The hottest day in the year on the average is July 15 and the coldest January 12. A sufficiently close confirmation of the hottest period is afforded by the fact that out of 40 days on which extreme temperatures exceeding 90° have been recorded, 18 have occurred between the 5th and 24th of July. These and many other marvels may be found in this instructive volume, which may be commended to leader-writers and the like as a most valuable storehouse of information.

We have nothing but praise for the printing of this mass of figures, the type although small, being very clear and regular; and we are much pleased to note that the book is marked for sale at a very moderate price, unlike many publications of a similar class.

Méthode Graphique pour la détermination des Heures approchées des Éclipses du Soleil et des Occultations*.—We have to thank M. Cruls for a very useful book. It often happens that we have to compute the approximate circumstances of the occultation of a star not given in the 'Nautical Almanac,' and no doubt this happens more frequently to other persons who observe away from the meridian of Greenwich. To such persons this book will be of great value: it gives, in fact, convenient tables for finding the correction for parallax for any latitude and any hour-angle, together with instructions for, and examples of, the computation of the circumstances of eclipses and occultations by graphical methods, not complicated by attempts at great accuracy.

NOTES.

Comet Notes.—Several photographs of Perrine's Comet were obtained at the Lick Observatory in November last. The main tail was 1° long on Nov. 18, 5° long on Nov. 26. A shorter but brighter tail made an angle of 30° with this on the north side of it. Prof. Campbell examined the spectrum both visually and photographically, and found it of the usual type, viz. a faint continuous spectrum due to reflected light, and bright bands and lines due to incandescent carbon and nitrogen (Publications of the Astron. Soc. of the Pacific, vol. vii. no. 45).

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* Observatoire de Rio de Janeiro, 1894.

The following ephemeris is for Greenwich midnight:—

	R.A. h m s	N. Dec. ° ′		R.A. h m s	N. Dec. ° ′
Feb. 28....	19 46 40	1 40	Mar. 19....	19 43 20	7 11
Mar. 9....	19 46 6	4 24	29....	19 38 4	10 2

The comet should be visible with good instruments during March, being still $\frac{1}{10}$ of the brightness at discovery, and rising 4 to 5 hours before the Sun. It was observed on February 13 both at Kiel and Copenhagen, the place agreeing well with both Lamp's and Campbell's ephemerides. It is described as tolerably bright and large, with a faint tail, and a stellar nucleus of the 11th or 12th magnitude.

Mr. Perrine found a new bright comet on Feb. 15, only some four degrees distant from the above comet. He erroneously concluded that this was the object which Prof. Lamp had observed on Feb. 13, and telegraphed to this effect to Kiel. Prof. Lamp was able to verify the discovery of the new comet within two hours of the receipt of the telegram, and it will be known as Comet Perrine-Lamp. The comet was observed at Pola two days later, and is moving rapidly northward and eastward. Prof. Lamp describes it as brighter than Perrine's first comet, but with a somewhat similar appearance.

The following elements are by Dr. Lamp from observations on Feb. 15, 16, 17:—

T = 1896 Jan. 31·999 Berlin M.T.
ω .... 358° 38′
☊ 208 36
i 155 30
log q .. ... 9·7702

The following ephemeris, for Greenwich midnight, has been computed from these elements:—

	R.A. h m s	N. Dec. ° ′		R.A. h m s	N. Dec. ° ′
Mar. 2....	0 45 6	51 26	Mar. 18....	3 33 44	46 9
6....	1 58 20	51 11	22....	3 48 38	44 51
10....	2 44 2	49 29	26....	4 0 20	43 46
14....	3 13 24	47 42	30....	4 9 44	42 53

The brightness is 0·7 of that at discovery on March 2, but it falls rapidly, and on March 30 is only 0·035.

The comet was nearest the Earth (35 millions of miles) on Feb. 23. On Jan. 31 it was only 13 millions of miles from Venus. The fact that the axis of the orbit lies so nearly in the ecliptic makes periodicity probable, but the elements do not closely resemble those of any known comet.

Mr. Charles Lane Poor gives the following elements and search ephemeris for Comet 1889 V. (Brooks) (Ast. Journ. 364):—

T = 1896 Nov. 3·938 G.M.T.

☊	18° 1′ 8″	1896·0.
ω	343 47 35	
i	6 3 34	
log *a*	0·567341	
log *e*	9·671575	
log μ	2·698996	

	R.A.	S. Dec.		R.A.	S. Dec.
	h m	° ′		h m	° ′
Mar. 5	19 52	26 5	Mar. 29	20 34	24 27
13	20 6	25 35	Apr. 6	20 47	23 50
21	20 20	25 2	14	21 0	23 11

The above ephemeris is for Greenwich midnight, and may be in error some 2^m and 7′. The comet should now be brighter than when last seen at the Lick Observatory in January 1891, but it is badly placed for European observers. A closely accordant ephemeris is given by J. Bauschinger in Ast. Nach. 3334.

Mr. R. A. Fessenden contributes to the 'Astrophysical Journal' for January an article on an electrical theory of comets' tails. He suggests that a comet's tail consists of negatively charged particles driven off from the nucleus by the action of the ultra-violet light of the Sun, and that its shape is the resultant of four forces, viz.: (1) the solar gravitation, (2) the electrostatic repulsion of the Sun, (3) the electrostatic attraction of the positively charged nucleus, (4) the repulsion of neighbouring particles in the tail. Starting with Prof. Bredichin's results for the speed with which the tail matter leaves the nucleus, he deduces the potential of the Sun to be 15,000 volts. He shows how the theory accounts for the increase in the tail and diminution of the head as the comet approaches the Sun, and for the return of the tail-particles to the head when the comet has receded to a certain distance from the Sun. Rapid variations in the size of the tail and development of new tails may result from the splitting up of the nucleus. When such a splitting occurs, the two portions are driven apart by electrostatic repulsion, which would account for the phenomena of Biela's Comet. Since the positive charge on the nucleus is continually increasing, the attraction between it and the Sun is continually increasing. This would account for the acceleration of Encke's Comet.

He further accounts for the alternations in brightness observed in the two portions of Biela's Comet, and suggests that comets may be used as electroscopes, giving us the potential of the Sun and possibly, in time, of the planets.

The same number contains an article by Mr. Barnard on Holmes' Comet, illustrated by a photograph taken with the Willard lens on 1892 Nov. 10, the field including also the Andromeda nebula. (He remarks that this is the only photograph of the comet he has heard of taken during the early days of its apparition; he appears to have overlooked one that was taken by Dr. Roberts on the same night, which he presented to the Royal Astronomical Society.) This photograph shows a curious large nebulous appendage near the comet, connected with it by a short tail. Mr. Barnard does not think it likely that this object will ever be seen again as a comet, its nebulous appearance being probably due to some temporary accident. He thus describes its appearance on Nov. 8, 1892:—"Its appearance was absolutely different from that of any comet I had ever seen. It was a perfectly circular and clean cut disc of dense light, almost planetary in outline. There was a faint hazy nucleus."

Dr. Rambaut has published a paper giving the details of the measurement of two photographs of Encke's Comet, taken by Mr. W. E. Wilson on 1894 Nov. 30 ('Proceedings of the Royal Irish Academy,' ser. 3, vol. iii. no. 4). The orientation of the plate was determined from two known stars, and the comet's R.A. and declination were deduced from the nearer of them. The errors of Dr. Backlund's ephemeris in R.A. and declination (tabular —observed) are $+1^{s}\cdot2$, $+37''$.

M. du Celliée Muller writes that he observed a bright comet near Venus on the morning of Dec. 8 last. No further observations were obtained nor was the comet seen elsewhere.

A. C. D. C.

Minor Planet Notes.—A new planet, CO, was discovered by Wolf on Feb. 7.

A. C. D. C.

On some Points in the Reduction of Star-places.—In two recent numbers of the 'Astronomical Journal' (nos. 364 and 365) two important papers have been published by Dr. Chandler and Prof. Newcomb respectively on methods of reducing the declinations of a star catalogue to a subsequent epoch. The papers are somewhat technical, and as they agree to some extent in criticizing methods adopted by Prof. Auwers in forming the Fundamental-Catalog of the Astronomische Gesellschaft, it may help the explanation which we are endeavouring to give here, without expressing an opinion, if we briefly state the principle of this system.

The A. G. system is constructed by a comparison of the declinations found by Bradley for epoch 1755 with modern authorities of epoch about 1865, which are reduced to a mean system. From this comparison mean corrections for groups of stars are deduced and applied to Bradley's observations, and then by comparison of the places of individual stars for the epoch 1755 thus reduced and the places of the mean system proper motions are deduced, which can be applied to the mean system to find the place at *any* subsequent epoch. It is the application of the proper motions for any length of time which Dr. Chandler contends is a bad practice. He seems to imply that it is a mistaken principle to base a catalogue of stars for epoch 1890·0 on observations made so far back as 1865, as error may accumulate from uncertainty of proper motion. Dr. Chandler followed a different plan in his investigation of the coefficient of nutation, on which we had a note last month, and comparing the places of certain stars reduced by his method, with the places of the same stars found from the system of the A. G., the differences were so pronounced as to induce him to speak very strongly; he says:—"The real meaning of these comparisons can hardly be mistaken. Taking them together with other facts pointing in the same direction, we must conclude that the system of the 'Fundamental-Catalog,' admirable as it was for its original purpose, has now broken down, and that the extension of its employment up to the present time, and certainly for the future, should cease. The use of Bradley as absolute for computing proper motions was shown by the inexorable logic of Boss, twenty years ago, to be a principal that must be abandoned, ... to continue the prevalent practice of elaborately deducing declinations and proper motions from catalogues of various epochs by the use of systematic corrections referred to a fundamental system resting absolutely on Bradley is simply to spoil good observations made with our refined modern instruments, and to perpetuate in continually increasing ratio the defects of Bird's old mural quadrant."

Prof. Newcomb's paper is mainly a comparison between the method of forming fundamental declinations adopted by Prof. Lewis Boss and that by Prof. Auwers, and contains numerical statements of differences found by comparing the declinations of Boss with similar declinations found from Auwers-Bradley and the Greenwich and Pulkova catalogues, which show a marked difference in the case of the Auwers-Bradley. His point seems to be that the mean correction to the Bradley declinations should not have been applied, but that they caused errors, which is Dr. Chandler's conclusion, in the adopted proper motions of the A. G. system, which, if used for reducing to an epoch after 1900, will reach a serious amount. It is fortunate, Prof. Newcomb says, that the zone catalogues which depend on this system depend on observations made not long after 1865, so that no serious trouble has been caused at present.

HARVARD COLLEGE CIRCULAR, No. 5, relates to the variable star B.D. + 17° 4367 (called Wells' Algol Variable), the discovery of the variability of which was announced in Circular No. 3 [*].

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[*] See 'Observatory' for January.

Minima were predicted for January 5 and January 10, and preparations were made for observing it photometrically and photographically at Harvard, but, owing to clouds, no observations were possible on January 10, and only a few were made on January 5. Observations were obtained on this earlier date at Princeton and Andover. The manner of its variability is thus described in the circular:—"For nearly two hours before and after the minimum it is fainter than the twelfth magnitude. It is impossible at present to say how much fainter it becomes or whether it disappears entirely. It increases at first very rapidly and then more slowly, attaining its full brightness, magnitude 9·5, about five hours after the minimum. One hundred and thirty photographs indicate that during the four days between the successive minima it does not vary more than a few hundredths of a magnitude. The variation may be explained by assuming that the star revolves around a comparatively dark body and is totally eclipsed by it for two or three hours, the light at minimum, if any, being entirely that of the dark body. The conditions resemble those of U Cephei."

EXPLOSION OF A METEORITE OVER MADRID.—The following extract from 'Symons's Monthly Meteorological Magazine' appears to be a trustworthy account of a startling phenomenon reported in the newspapers of February:—

"Reuter's Agency reported from Madrid that on Monday, February 10, at 9.29 A.M., a vivid glare of blinding light was followed in 1½ minutes by a loud report, the concussion being such as not merely to create a panic, but to break many windows, and in some cases to shake down partitions. The sky was clear, and the Sun shining brightly, when a white cloud, bordered with red, was seen rushing from S.W. to N.E., leaving behind it a train of fine white dust. A red-tinted cloud was long visible in the E.

"If all the statements are correct, we should infer that the meteor was of exceptional magnitude, probably weighing from 100 to 300 lb., and that it burst within about 15 miles of Madrid, but very probably at a considerable altitude above the soil.

"We notice that Reuter's Agency calls it an 'aerolite.' We thought that an aerolite differed from a meteor or meteorite in that the former was chiefly stone, the latter chiefly iron and nickel; but on turning to a dictionary we find no distinction drawn between the two; and, worse still, on looking into the best English book upon the subject, Dr. Flight's 'Chapter in the History of Meteorites,' we find the two words used indiscriminately."

α AND β CENTAURI.—Several papers have recently been published relating to these stars, all more or less technical, but no doubt of interest to those who study the refinements of stellar astronomy. It may be sufficient to give references to these. In 'Ast. Nach.' 3330, Dr. Doberck gives two determinations of the elements of the binary system α Centauri, with an ephemeris. From one set of elements he draws the conclusions that the sum of the elements is 2·3780 of the Sun's mass, so that each of the stars, if they are not very unequal, is about equal in mass to the Sun. With the parallax 0″·75, the major semi-axis is 24·60 of the distance between the Earth and the Sun, so that the distances of the components are about the same as the distances of the farther planets from the Sun.

In the same number of the 'Ast. Nach.' Mr. Alex Roberts discusses some systematic differences in meridian observations of α_1 and α_2 Centauri made at the Cape Observatory, and suggests that a study of these may lead to possible improvement in meridian observing, and the same astronomer, in 'Ast. Nach.' No. 3334, publishes a paper on the position and parallax of β Centauri, deduced from observations at the Cape Observatory.

SUN-SPOTS IN RELATION TO THE SUN'S DIAMETER.—In Ast. Nach. No. 3330 there is a paper by M. Sykora, of the Charkow Observatory, giving some observations which go to show a new fact in solar physics. The Sun's diameter has been measured at the points of the limb where sun-spots have just appeared or where they are about to disappear. The diameter measured at these points was found to be greater than that measured at points near them, which is taken to show that sun-spots cause elevations of the solar surface in the regions around them. The following are some measures given in the paper:—

Date.	Diameter through Spots.	Adjacent diameters.	
June 22 ……	$2^{m}\ 8^{s}{\cdot}62$	$2^{m}\ 8^{s}{\cdot}38$	$2^{m}\ 7^{s}{\cdot}97$
July 5 ……	8·37	8·04	8·21
12 ……	8·30	8·27	8·27
Sept. 5 ……	8·52	8·25	8·44
9 ……	8·41	8·29	8·36

WE regret to have to announce the death, which took place on February 16, of General J. T. Walker, F.R.S., an officer much interested in Astronomy, especially in the branches connected with the science of Geodesy. General Walker was born in 1826 and joined the Bombay Engineering Corps in 1844. In 1852 he joined the Indian Trigonometrical Survey, and succeeded Sir Andrew Waugh as Superintendent of that work in 1861. Under his direction many volumes were published giving the observations and results of the work of the Survey, which bear evidence of his care and scientific accuracy. He retired from this post in 1883, having for the last five years combined with it the office of Surveyor-General of India. After his retirement General Walker did not entirely relinquish scientific activity. He was frequently consulted by the Government on matters connected with science in India: he was a member of the Indian Observatories Committee, and in 1889 he superintended some experiments for determination of relative gravity made at Greenwich and Kew with the Indian invariable pendulums. General Walker took great interest in geographical science, and was a prominent member of the Geographical Congress of last year.

THE death is announced of Mr. G. P. Bidder, M.A., Q.C., a Fellow of the Royal Astronomical Society, who has not taken an active part in astronomy lately, but was formerly a frequent attendant at the meetings and read an occasional paper. He was remarkable as being the son of the engineer who was known as the phenomenal "calculating boy," and it is said that Mr. Bidder largely inherited the paternal talent in this direction, and could, among other such feats, multiply 15 figures by 15 figures mentally.

THE LUNAR ECLIPSE OF FEBRUARY 28.—This almost total Eclipse of the Moon as seen at Greenwich was of little value from the point of view of the observer of occultations. A clear sky at sunset gave promise of a fine evening, but an hour later the sky was covered by scattered cloud and the Moon was not visible at the time of any of the five predicted occultations. Nevertheless, the eclipsed Moon was frequently well seen in breaks of the cloud. The edge of the shadow was very sharply defined and at half-past seven, seen through a thin cloud, the Moon had exactly the appearance she has when two or three days old. One observer, who noted the appearance very carefully, says the Moon as it rose and before it got into the shadow was red, and afterwards was of bright copper colour; others describe the colour as mahogany or claret. The eclipsed portion as to brightness and tint was much as in the eclipse of 1895, March 10, but craters and the principal Tycho streaks were plainly seen when in the shadow.

REMARKABLE COMETS.—The editions of Mr. Lynn's useful little book with this title appear with the regularity of an almanac. The first edition was published in January 1893, other editions have appeared each year, so that we have lately received a copy of the fourth. We have before spoken of the usefulness of this as a book of reference and history, and the fact that the history is kept quite up to date year by year obviously does not lessen its value. We have no need to speak further in its praise.

THE SOLAR ECLIPSE OF 1896, AUGUST.—We learn from 'Publications of the Astronomical Society of the Pacific,' vol. viii. p. 47, that an expedition under the auspices of the authorities of the Lick Observatory will proceed to Japan under the direction of Prof. Schaeberle. The expenses of this will be generously defrayed by Col. C. F. Crocker, who is one of the Regents of the Observatory, and who paid the expenses of the Lick Observatory Eclipse Expedition to Cayenne in December 1889. The programme provides wholly for photographic observation. Prof. Schaeberle will make large scale photographs of the corona with a lens of 40 feet focus, and smaller scale pictures will be taken with the 5-inch Floyd photographic telescope. Mr. Burckhalter will photograph the corona with a telescope of 4 inches aperture and 20 feet focus. Other members of the party will be Dr. G. E. Shuey and Mr. L. C. Masten, and Dr. Terao, Director of the Tokyo Observatory, will allow one of the members of his staff to join the expedition in Japan.

THE same number of the 'Publications of the Astronomical Society of the Pacific' contains a protest by Prof. Holden, vigorous and not unamusing, against the practice of distinguishing minor planets and other celestial objects by the names of terrestrial royalties or of persons far removed from royalty. He recalls the fact that when Mr. Hind named his planet *Victoria,* Dr. Gould protested, as this was "at variance with established usage," but that Mr. W. C. Bond pointed out that Victoria was the name of a mythological personage. Prof. Holden prefers, although he thinks he speaks too late, that the nomenclature of celestial bodies should be drawn from mythological or ancient historical sources, and that a list of the minor planets should not read like the names of a girls' school, nor that a chart of the Moon should contain a crater named in honour of Mrs. Jackson-Gwilt.

HERR VON KARL SCHWARZCHILD has, in the Ast. Nach. 3335, a method of measuring double stars by means of the interference of light. He places an apparatus with parallel slits in front of his object-glass. The measures of the twelve stars given are very good *inter se.* The class of star measured can be seen from the fact that the following stars—γ Leonis, ξ Ursæ Maj., ι Coronæ, λ Ophiuchi, 70 Ophiuchi—are given in his paper.

A REUTER telegram in the 'St. James' Gazette' says:—"The committee charged with the reorganization of the Athens University met yesterday, under the presidency of Prince George, to discuss the best means of obtaining a large telescope, which it was pointed out would be of great service to astronomy owing to the clearness of the sky in Greece. The telescope will be ordered from France."

MESSRS. GAZE & SONS inform us that the berths on the S.S. 'Norse King,' which they are sending to Norway for the eclipse in August next, are nearly all taken. A second steamer will be sent by the same firm if necessary.

A NEWSPAPER paragraph, which we have no means of verifying, states that Berlin is to be the next city to have the largest refractor in the world. It is proposed to make an objective of 44 inches diameter.

A NEW method of computing a double star's orbit is given by Herr von H. F. Zwiers in the Ast. Nach. 3336. He applies his method to work out the orbit of Sirius.

FROM AN OXFORD NOTE-BOOK.

"A NAMELESS amateur who finds little sympathy," writes me the following postcard from Portugal:—"The inaccuracy involved in the astronomical joke you quote from *Punch* in the last number of *The Observatory* is certainly very judiciously expressed. Very probably '*they lies.*' Yet I have always remarked that for celestial dimensions given in that way, the measuring-rod is not thought of generally at arm's length, but further. I have heard, for instance, the Moon very often compared to a small dish or to a saucer; the length of a comet's tail (1882), 'apparently some metres,' and so on. But on reading that quotation I could not help feeling some regard for the astronomical education it implies in the average reader of that journal to be able to understand the fun of it. The newspaper readers I am acquainted with would think it a very correct method of measuring the heavens, that which Bertha used,—save for the *umbrella standard.* One must grant that the much slandered average reader has some little astronomical (or at least geometrical) attainments. Would to God he were so far advanced everywhere in Europe!"

I THINK I am right in gathering that though my unknown correspondent does not mind my little joke, it suggests to him reflections of a more serious kind; and I trust that he will forgive me for printing his words in the hope that they will call forth that sympathy which he fails to find; though I fear it must remain unexpressed owing to his anonymity. There *is* a serious side to most jokes. Had I been going to write a serious essay on some point suggested by this particular one, however, I think I should have chosen to insist further upon that feature which my correspondent is disposed to condone. I grant him freely that the practice of referring the apparent distances of points on the celestial sphere to a radius of something like 10 or 20 feet is a common one; but it is entirely different when any one says "*I have measured.*" The whole beauty of experimental science lies in the power of the simplest appeal to facts to dissipate preconceived notions; and if, as I said before, this were going to be a serious essay suggested by a joke, I should be inclined to try and point out the importance of never putting down wrong facts if it could possibly be avoided. But I must at once disclaim any originality in this idea: it is practically a remark of the late Charles Darwin which I heard repeated by his son, to the effect that false theories do comparatively little harm; but the publication of a false fact is a serious matter.

It is perhaps the chief value of a scientific education that the great importance of facts is made evident. Even history compares unfavourably with science as an education from this point of view, as the following quotation may illustrate. In the recently published 'Reminiscences of Mrs. De Morgan,' there is a sketch of the life of her father, William Frend, who was Second Wrangler and Smith's Prizeman in 1780. He had a serious difference with the University, and incidentally has occasion to remark on the importance of accurate facts as follows (the italics being mine):—"In the University question my opponents were baffled by my proving that there was no such law in existence as the pretended one on which my opponents defended themselves. Strype, in his 'Annals,' and the author of the 'History of the Puritans,' had both asserted that such a law had passed on the day they mentioned. *This is a curious circumstance, and shows how little historians are to be depended upon in matters of fact.*"

General Tennant makes the following interesting comment on the discussion at the January meeting of the R.A.S.:—"Looking at the Report of the meeting of the R.A.S. I was much surprised to find that while absorbing media were recommended to reduce the light in large telescopes, no one seems to have spoken of a plane glass reflecting surface such as is used for diminishing the light and heat of the Sun. I cannot conceive that no one has used this arrangement, or that it has failed when used: at all events I have used it constantly even with a six-inch for the Moon, and can speak very well of it; it will, I think, be found especially valuable when observing occultations at the bright limb. I have also used it occasionally for Jupiter and other planets when bright; but on the whole I preferred, with my moderate aperture, illumination of the field with claret-coloured light, for the suggestion of which I was indebted to some writing of Sir J. Herschel. Though the planets did not give enough light to make the plane glass reflector always efficient with the means at my command, it by no means follows that the plan would not do well with the large telescopes now so general, when only low powers can be employed. I should think that a polarizing eyepiece would even be preferable to an absorbing medium for reducing light; I mean, of course, the reflecting form. At all events I should be glad to learn that some one had tried it fairly."

When there are only 28 days in the month, or even 29, the end of it seems to come very quickly, and the tale of bricks is apt to be deficient, especially when disturbing causes such as annual reports and eclipse arrangements, not to mention women's degrees, claim a large share of the month to themselves. It was therefore with a feeling of great joy that I received the following note from the Editor-in-chief:—

"The enclosed cuttings have come from the Cape. As the poetry generally goes on the last page, I thought I would send them to you."

The cuttings refer to the unification of time—an important subject enough, and are, I trust, worth reprinting. They ought to make quite two pages of "copy."

THE NEW TIME.

A STRAIGHT TALK BY THE SUNDIAL.

The General Manager of Railways has recently issued a circular to local bodies throughout the Colony, urging the adoption of a uniform time for all South Africa. Under this arrangement, if accepted, the proclaimed time in Cape Town will be no less than 46 minutes in advance of the actual hour. Such a condition of things is naturally calculated to upset the equanimity of the venerable Sundial in the Municipal Gardens, which accordingly launches forth as follows:—

A hundred years I've faced the sky upon my pedestal,
And with my finger's shadow shown the hours of day to all;
And though some scars of age I bear, I challenge any man
To say my record's less correct than when I first began.
And still with my old friend the Sun the time I might be telling
When all who read my face to-day have reached a sunless dwelling;
And now some meddling idiots a new-fangled fad have started,
Which'll turn me to a laughing-stock, and leave me broken-hearted.

We let the wretches have an inch, and now they ask an ell,
And what they'll want before they stop is more than I can tell;
I quite expect to see a law gazetted very soon,
That all must rise at sunset, and go to bed at noon.
Ah, Hamlet! if you lived to-day, your luck you well might curse,
For the time's already out of joint, and these would make it worse;
They'll tinker with the compass next, or "cook" the calendar,
Till simple folk begin to feel they "dunno where they are."

O Elliott, Mr. Elliott, deep the grudge to you I owe;
And did your fate depend on me, I guess you'd have to go.
For *I* am not deluded by a subtlety sublime
Which seeks to show its up-to-date by being out of time.
Besides, if one hour everywhere is a necessity,
Then, surely, Cape Town should dictate what that one hour should be;
And Durban and Johannes*dorp* and Delagoa Bay
Should come to us—to ME—to learn the proper time of day.

Of course, the clocks won't mind the change—that wretched servile race,
Each with hands for ever sneaking round and round its foolish face.
You can turn a key inside them (so I'm told) and make them say
That it's half-past nine to-morrow when it's really six to-day.

But we sundials have got consciences, and listen to them too;
We just say what the Sun tells us, and of course that *must* be true.
And a hundred Gills and Elliotts cannot "square" us though they try,
For it takes a man like Joshua to make *us* tell a lie.

So all ye Railway Managers, ye Governments beware!
And trifle with the Sun-appointed hours if ye dare;
For a clock to strike is nothing, but you don't know what it's like
When an honest, earnest Sundial goes fairly out on strike.
But stay, I must be prudent, for if Rhodes gets on my track,
All my century of service might be ended with the sack;
So I'll smother my annoyance, and declare my fixed intention,
Of sending in my papers and applying for a pension.

THE TRUE TIME.

A REPLY TO THE OLD SUNDIAL FROM THE TRANSIT INSTRUMENT OF THE ROYAL OBSERVATORY.

A hundred years you've faced the sky upon your pedestal,
A hundred years and you have seldom told the truth at all.
Your record, true, is as correct as when you first began,
But oh, the lies that you've been telling poor confiding man.
In your old friend the Sun, my boy, it does not do to trust,
I think it really time that you were resting in the dust;
If you so very truthful were, you would most plainly see,
I should not have to watch at night, there'd be no work for me.

From day to day you vary so, I think it very wrong,
Sometimes you make the day too short, sometimes again too long;
And those who put their faith in you will much regret to hear
That you are only quite correct just four times in the year.
In February you will be some fourteen minutes slow,
But now you're sixteen minutes fast—is that the way to go?
'Tis I must regulate the time, 'tis I must tell it right,
And so I keep a steady watch upon the stars at night.

THE NEW TIME.

LAST WORDS BY THE SUNDIAL.

(*A Rejoinder to the Transit Instrument.*)

O sneering Transit Instrument! I call it more than mean,
That you for my discomfiture should dare to intervene,
The wrath of Time-reformers I should really scarce have felt,
But you have fairly floored me with this blow below the belt.
We might have worked together and upset the hateful scheme,
But in your spiteful hope to score, you've spoilt that happy dream,
For now the people know their Time-physicians don't agree,
They'll set their clocks to suit themselves, and sack both you and me.

I know the Sun goes wrong at times, it is my secret sorrow,
But if he lags behind to-day, he sails ahead to-morrow;
And so I thought twixt this and that, my time was as correct
As any erring mortal was entitled to expect.
But now, of course, the game is up, the fat is in the fire,
And naught remains for me to do but gracefully retire.
But ah, you sneaking reptile, could I get at you to-night,
Such stars as you have never seen would dance before your sight!

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 239. APRIL. 1896.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, March 13, 1896.

Dr. A. A. Common, F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. Turner, M.A., B.Sc., and
E. W. Maunder.

Mr. Maunder read the Minutes of the January Meeting, which were confirmed.

Mr. Maunder. 116 presents have been received since the last ordinary Meeting. Amongst those calling for special mention are the ninth volume of the 'Collected Mathematical Papers of Prof. Cayley,' presented by the Cambridge University Press; two volumes from the Lick Observatory, one of which is of special interest at the present time, being a report of the total eclipse of the Sun observed in Chili on April 16, 1893, by Prof. Schaeberle. Dr. Weinek sends a number of enlargements from negatives of the Moon, taken with the equatorial in Paris; and we have received from Mr. Newbegin four lantern-slides of the lunar eclipse of Feb. 28 last.

Prof. Turner. The papers received include one from the Astronomer Royal for Scotland, giving some observations of comets; and I should like also to call attention to a small paper communicated by Mr. H. C. Plummer, son of Mr. W. E. Plummer, on a graphical method of solving Kepler's problem, which I think is a distinct advance upon the previous methods I have seen. There is also a paper, by myself, on a curious light seen at Oxford on March 4 last, which is probably an instance of the phenomenon known as the zodiacal light. The paper is a combination of two notes, one made at the University Observatory by Mr. Bellamy, who saw this light and called my attention to it. The second part of the paper is a note communicated independently by Sir W. J. Herschel, who has sent a sketch which gives a very good notion of the appearance. This zodiacal light was seen much in the ordinary shape in the early part of the evening between 7 and 8 o'clock, but about a quarter to 9 there was seen a very bright axis of the zodiacal light which did not remain very long. Sir Wm. Herschel thought it was a comet, and Mr. Bellamy thought it must have been a comet, and got out the telescope to examine it. Some persons suggest that it might have been an aurora, and aurora was seen about midnight in the north. It was seen not only near Oxford but also at Wolverhampton. Mr. Stone has sent a note on the same subject.

Sir Erasmus Ommanney. What is the length of the arc over which it extended?

Prof. Turner. About 10°; it was not recognizable as an aurora at all.

Major Kingsley-Foster. I saw a similar thing at Redhill last Sunday; it was to the east of north, not in the north-west.

A Fellow. How long was it visible?

Prof. Turner. It was first seen at a quarter past 9, but it may have been visible before that. Sir W. Herschel records his observation at 8.55. When I was called out at 9.20 it was very faint, and it was recorded as being so faint that it was scarcely perceptible.

Mr. Newall. On March 4 my assistant saw the same thing at Cambridge. I saw the aurora about half-past 10, but he told me that he had seen a ray similar to that moving very slowly during the 20 minutes he observed it; I think he said southwards. It was seen in the due west, and he described it with regard to the stars in Aries and the Pleiades. Later on I saw two smaller rays which were obviously aurora borealis streamers, as they showed the green lines of the aurora.

Mr. Maunder read a letter from a correspondent at Shrewsbury describing similar observations.

Prof. Turner. We have a letter from Mr. Russell, Sydney, enclosing a letter from a correspondent named A. E. Parker, which gives details of a similar observation, but of much earlier date, as the date of the letter is 1895 Dec. 27.

The President. These observations are very remarkable. The question of what this ray of light really was I suppose never will be settled; but I have always felt since a comet was found in 1882 near the Sun during the eclipse that there may be a large number of comets going past the Sun which are never observed, and this might have been one; but it might just as well have been an extension of the aurora borealis. When I saw the picture of it I came to the conclusion that it was too vertical for our latitude. Zodiacal light is a phenomenon very seldom seen. I remember in November 1882, at about the time of the great comet which was observed so close to the Sun at the Cape, on several consecutive fine mornings, the zodiacal light showed remarkable brilliancy. It had all the appearance of condensation increasing towards the horizon in the Sun's path. I think on the whole it was not the zodiacal light which these gentlemen saw. It might have been a comet, but of course one cannot say with certainty. It is particular that the time of the observation and position of the object should be recorded, for it may turn out to have been a comet. Zodiacal light is seen in the evenings of the spring and the mornings of the autumn.

Father Sidgreaves. Supposing it to be a comet, it would have been visible on preceding and following nights. It is not uncommon to have streamers quite near the Sun. If it remained a fine night afterwards, the question of a comet would be settled at once.

Prof. Turner. I think it distinctly faded.

Father Sidgreaves. That would be precisely what it would do as an aurora.

The President. I have watched these aurora-streams, and generally the fading takes place in the course of a few seconds.

Father Sidgreaves. I have seen them last a considerable time. We had a remarkable one last year right across the zenith which lasted 20 minutes.

The President. As a rule the aurora is seen quite in the north. The generally accepted explanation is that the appearance is due to the beams of the Sun seen by reflection in the northern quarter of the sky; but I do not know that it is impossible that it should be seen in any other region. But in view of the fact that in 1882 an object was found near the Sun, by photography, by the Eclipse observers in Egypt, which was supposed to be an enormously bright comet with rapid motion—that was never seen in daylight—I think it possible that this light might be due to such an object. There is no record of that comet at all except the photograph taken by Schuster; and from the photograph it must have been bright enough to have shown a very long tail. This appearance, as shown on the diagram, does not follow the lines which the line of the zodiacal light would naturally follow.

Mr. Taylor. Mr. Turner said that Sir W. J. Herschel determined the position of the zodiacal light and the position of the stars, so there is little doubt that the axis of this beam of light was parallel, and practically in the centre of the axis of the zodiacal light.

Prof. Turner. That is so.

Mr. Taylor. So we have a confirmation that the inference as drawn by Herschel is correct.

A Fellow. Was any change of colour observed?

Prof. Turner. No; I do not think so.

Several lantern-slides from photographs of the eclipse of the Moon of February 28, presented by Mr. Newbegin, were then shown on the screen.

The President. These photographs show that there is nothing new in this world. In 1875 I took a series of photographs of the eclipse of the Moon, and I could find absolutely nothing more nor less than a gradual shading away of the light of the Moon. There is one photograph I often have wished to see, and that is of the lunar eclipse with the Moon totally obscured *but visible.* On consideration, you will see that we never see the Moon when it is actually full except when the Moon is seen at the moment of totality during an eclipse.

Mr. Thackeray then read a paper on the "Proper Motions of certain Fundamental Stars." The principal proper motions of 36 fundamental stars have been determined from the Greenwich observations 1836–93, reduced to one equinox and one system of declination. The results in Right Ascension are compared with the values adopted by Auwers, and in declination with those adopted by Auwers and Boss, and those lately deduced by Chandler from the Greenwich mural-circle observations, 1825–1848. The Greenwich values lie between Auwers on one side and Boss and Chandler on the other side. The correction to Boss's system is found to be $+0''\cdot68$ T, where T is the time from 1850 in units of a century, which is fairly accordant with the value found by Newcomb from his planetary theories, $+0''\cdot42$ T. The Greenwich results also closely correspond to those deduced by Chandler from the Pulkowa Catalogues 1845 and 1885, and the systematic difference between them and those deduced by Chandler can be explained by the difference in the value of the colatitude adopted by Chandler in the reductions of the Greenwich mural circles and that now adopted at Greenwich. The corrections applied by Auwers to Bradley's declinations, though aggravating the large discordances shown to exist in certain zones, appear to be in the main beneficial; the mean result, as far as the stars under discussion are concerned, is quite small, $+0''\cdot18$.

Dr. Downing. This is a very technical subject, and perhaps it is hardly suitable for discussion; but it might be worth while drawing attention to one point, and that is, that the results which Mr. Thackeray has obtained differ considerably from those found by Prof. Newcomb. That is, I think, due to the fact that Mr. Thackeray discusses a strictly limited number of stars, and that Prof. Newcomb takes a large number of stars in particular zones. Prof. Newcomb shows that a considerable difference exists in certain zones between the declinations deduced by Prof. Auwers and Prof. Boss, and Newcomb comes to the conclusion that the corrections applied by Auwers to Bradley's observations for errors in the plane of the quadrant &c. ought not to have been applied. I gather from Mr. Thackeray's paper that the conclusion at which he arrives is that the correction to Boss's system deduced from Greenwich observations is in agreement with that deduced by Prof. Newcomb from his planetary investigations. That, I think, is very satisfactory.

The thanks of the Meeting were passed to Mr. Thackeray.

Mr. Lewis then read a paper on "Results of Micrometer Measures of Double Stars made at Greenwich in the years 1894–95." The measures were made with the 28-inch refractor, and the power generally used was 670, but a power of 1030 was sometimes used when observing close pairs and the night was favourable. Full details of the observations would be published in due course in the Greenwich volume. The measures given were the mean results, and the stars for observation were chosen from a catalogue made specially for the instrument. They had endeavoured this year to get a series of observations of κ Pegasi. The interest of κ Pegasi was that its period was smaller than that of any other binary excepting those known as "spectroscopic doubles," and appeared to be about equal to that of Jupiter.

Prof. Turner. The remaining papers received are hardly suitable for reading *in extenso.* Mr. Stone has sent a paper on the determination of the pivot errors of his transit-circle by a new method. This method depends on the optical principle known as Newton's Rings, which has been made use of in an apparatus made by Messrs. Troughton and Simms. Mr. Stone finds the pivots to be sensibly cylindrical. A paper has been received from Dr. Gill and Prof. Jacoby, who have investigated the errors of the *réseau* used at the Cape Observatory. The important result of this is that none of the errors is larger than $0^{\mathrm{mm}}\cdot0002$, and that quantity is smaller than the limit of accuracy to which we measure. For practical purposes this investigation gives much the same result as Dr. Gill's former one printed in the last volume of the 'Memoirs,' where he investigated the errors of the *réseau* used at Oxford, and found that the corrections to be applied to the measures of the Astrographic Chart were nearly insensible. I also have a note relating to the Astrographic Chart. It may be remembered that, in a paper by the Astronomer Royal and Mr. Dyson read at the last meeting, a small difference in the value of the scale of the plate in the two directions, parallel and perpendicular to the equator, had been detected by the measures. It occurred to me that this might be due to a tilt of the plate, *i. e.* that the line drawn from the centre of the object-glass normal to the plate did not fall on the centre of the plate as it should do. It appears that this is not so; but I call attention to this as it might occur in other cases. In this note I also make the suggestion that several fields might be photographed on one plate, and the plate constants determined from each field. The comparison of these would probably be of interest.

The President. I want to say a few words on the subject of Cassegrain telescopes. I had a letter from Prof. Schaeberle this morning on this subject, and also a photograph taken with such an instrument. As everyone knows, in the middle of the large mirror of a Cassegrain there is a hole through which the light reflected from the small mirror passes to the eyepiece. Schaeberle has been making experiments, and finds that a large amount of sky light comes through this hole as well as the light reflected from the mirror, and he proposes a plan to remedy this. The small tube in the hole which carries the eyepiece is to be extended down the tube towards the small mirror, which will have the effect of excluding extraneous light, and if it be carried halfway down the tube no reflected light will be lost. Some time ago I was consulting with the Astronomer Royal about making a Cassegrain telescope, to go on the Thompson equatorial at Greenwich, and a similar plan occurred to me, which I tried on a small terrestrial telescope which I have with a good effect. Herschel has said that a Cassegrain telescope is better than a Gregorian, inasmuch as the aberration of the convex mirror helps to correct the aberration of the concave; but he did not take into consideration the fact, which everyone who grinds mirrors knows, that the working of a convex surface is much more difficult than that of a concave.

The following papers were announced and partly read:—

J. Tebbutt. "Observations of the Variable Star R Carinæ, Dec. 1890 to Aug. 1895."

W. R. Brooks. "Discovery and Observations of Comet Brooks (*d* 1895)."

Lieut.-Col. Markwick. "Observations of the Variable Stars W, X, and Y Sagittarii."

Rev. T. Roseby. "Elliptical Orbit Elements of Comet 1894 *b* (Gale)."

J. Tebbutt. "Results of Double Star Measures at Windsor, N.S. Wales, in 1895."

David Gill and Harold Jacoby. "On the Determination of the Errors of the Cape Réseau."

Royal Observatory, Edinburgh. "Observations of Comets."

Prof. E. W. Brown. "Note on Mr. Stone's paper, 'Expressions for the Elliptic Co-ordinates of a Moving-point to the Seventh Order of Small Quantities.'"

W. F. Denning. "Fireball of 1895 November 22."

Prof. H. H. Turner. "On the Systematic Errors of Measures of Photographic Plates."

Prof. H. H. Turner. "Note on the Zodiacal Light as seen at Oxford, 1896 March 4."

A. W. Roberts. "Variation of T Centauri."

Royal Observatory, Greenwich. "Results of Micrometrical Measures of Double Stars made with the 28-in. Refractor, 1894–95."

W. G. Thackeray. "On the Proper Motions of certain Fundamental Stars."

Royal Observatory, Greenwich. "Observations of Comet *a* 1896 (Perrine-Lamp)."

H. C. Plummer. "A Graphical Method of solving Kepler's Equation."

E. J. Stone. "Note on the sensibly cylindrical form of the Pivots of the Transit-Circle of the Radcliffe Observatory, Oxford."

Radcliffe Observatory, Oxford. "Note on the Zodiacal Light of 1896 March 4."

W. H. M. Christie and F. W. Dyson. "Note on Prof. Turner's paper on the Systematic Errors of Measures of Photographic Plates."

The following Candidates were proposed for election as Fellows of the Society:—

William Banks, 30 Corporation Street, Bolton (proposed by J. R. Bridson).

Henry Frank Griffiths, Sherwood Villa, Angles Road, Streatham, S.W. (proposed by the Rev. W. R. Waugh).

Alfred Ernest Young, Assoc.M.Inst.C.E., Trigonometrical Survey, Taiping, Perak, Straits Settlements (proposed by James Simms).

The following gentlemen were elected Fellows of the Society:—

James Cavan, M.A., Eaton Mascott Hall, Shrewsbury; *Thomas Edward Knightley*, Clive House, Tulse Hill.

THE BRITISH ASTRONOMICAL ASSOCIATION.

The fourth meeting of the current session of the British Astronomical Association was held at University College, Gower Street, on February 26th, *Mr. E. Walter Maunder*, President, in the Chair.

The election of 14 new members was confirmed by the meeting, and the names of 14 candidates for election were read and suspended.

The President, in opening the proceedings, alluded to the fact that this was their fiftieth meeting, and congratulated the members on the very remarkable success and growth of the Association.

Mr. Edwin Holmes read a paper on "Jupiter: his Density, Atmosphere, and Clouds." Mr. Holmes referred to the generally accepted opinion that all the planets were probably constituted of the same materials, quoting in illustration passages from Proctor's 'Orbs around us' and 'Flowers of the Sky'; it appeared to him, however, that if they accepted the nebular hypothesis of the origin of the solar system the very contrary of this might be anticipated. The heavier constituents of the nebula would tend to form a nucleus first, leaving the lighter elements furthest from the centre. It might reasonably be assumed, therefore, that the small density of Jupiter depended, not alone upon his temperature, but partly, at least, upon the character of the elements of which he was constituted. This view seemed to be supported by the fact that Jupiter's moons shared his lack of density, although it was scarcely credible that they could have retained any considerable temperature.

Alluding to the views of M. Flammarion and Mr. Proctor as to the great depth of the atmosphere of Jupiter, Mr. Holmes saw no reason for thinking that the Jovian clouds were globular and as deep as they were large superficially. This was by no means the case even with terrestrial clouds, and considering how much more rapidly density decreased on Jupiter it followed that his clouds must be spread out in thin layers, being unable to penetrate the lower strata.

The President said that he agreed with Mr. Holmes in several important points which he had raised in his paper. With regard to the assumption that the composition of the different planets in the solar system was practically uniform, since Mr. Proctor wrote much evidence had come to light which pointed in an opposite direction. The evidence of the spectroscope showed no doubt that the same elements were found throughout nature, but by no means that they were equally distributed throughout the various celestial bodies. Helium obviously abounded in the Sun, but was found in very small quantities on the Earth. He also agreed with Mr. Holmes that the clouds on Jupiter must necessarily be relatively thinner than they were on our own globe.

Three papers on Recent Observations of Jupiter were then read, contributed by *Rev. W. R. Waugh*, director of the Jupiter Section, *Rev. T. H. Foulkes*, and *Herr Leo Brenner*. The two former papers described the changes taking place in the equatorial zone and the N. equatorial belt. The latter appeared to be diffusing itself into the equatorial zone, and melting away in a southerly direction.

Herr Leo Brenner's paper gave the tabulated results of his micrometrical measurements of the latitude of the belts on Jan. 23.

Mr. Maw asked whether Herr Brenner gave the mean results of his observations of the latitude of the belts. He had made micrometrical measurements himself and found the latitude of the belts exceedingly difficult to measure, except in the case of the temperate bands, which were very sharp and clear. The mean of four sets of measures which he had made were as follows :—

Latitude of N. temperate band (centre)....	22¼°
" " N. equatorial belt (centre)	9¼
" " S. equatorial belt (N. edge)....	8½
" " do. (S. edge)....	18
" " S. temperate band (centre)	28¼

The S. equatorial belt was, roughly, 10°/$_0$ wide.

The President said that Herr Brenner's figures appeared to be the result of single observations; they were as follows :—

N. temperate band (centre)	26 °
S. equatorial belt (N. edge)	8½
do. (S. edge)	21½
S. temperate band	30

Mr. Green said it was an interesting question, What were those dark belts? Most observers agreed to describe the light markings as clouds; but what were the dark markings—dark clouds or dark spaces? To him they always appeared as spaces through which they looked at what might be the body of Jupiter itself or a deeper layer of atmosphere; at all events, to his mind the lighter portions were floating at a higher level than the dark masses.

Mr. Maw said he had omitted to mention that there was a slight difference in the latitudes in different longitudes. The highest latitude of the S. temperate belt was 29½°, which agreed very well with Herr Brenner's 30°. The least latitude he had measured for the centre of the S. temperate band was 26½°.

The President drew attention to that portion of Mr. Waugh's paper which described the formation of the second shoulder below the red spot. That marking had been as long-lived and even more distinct than the red spot itself, and was even more significant, as if Mr. Green's theory was correct it must be the higher light-coloured clouds that defined the shape they were looking at, and they might well ask how it was that the white material retained its shape so constantly and for so great a length of time?

Mr. T. Gwyn Elger contributed a paper on "Certain obscure and partially destroyed Formations of the Moon." The writer referred particularly to those formations which were mostly found on the shore-line of the *Maria*, and had evidently, from some unknown cause, suffered collapse to a greater or less degree on the side facing those depressed plains. These remarkable objects appeared to him to be of the highest interest, as affording a possible key to the origin of the *Maria*.

A paper by the *Rev. T. H. Foulkes* was then read, discussing some recent observations of the floor of Plato. The writer thought there was some evidence of change at present taking place in the shape of rill-like formations, and suggested that the subject was well worth the attention of selenographers.

Mr. Overstall, of the firm of Messrs. Horne and Thornthwaite, exhibited and described a new departure in driving clocks for small equatorials, which could be fitted to an equatorial mounted on a tripod, as well as to one on an iron column. The cost was small, and the clock did not interfere with the hand motion of the telescope.

Mr. Hilger exhibited a stellar spectroscope which he had constructed for a member of the Association. It was intended for faint star work, and contained a number of special adaptations for that purpose.

Some slides by *Mr. Newbegin*, of photographs of Orion, the Pleiades, &c., were thrown on the screen.

Papers by the *Rev. T. H. Foulkes* on "The Trapezium in Orion," by *Mr. W. F. Gale* on "A New Ring Nebula," and by *Mr. A. Pannekoek* on "The Variation of R Lyræ," concluded the business of the meeting.

ROYAL METEOROLOGICAL SOCIETY.

At the Meeting of this Society on Wednesday evening, March 18, *Mr. E. Mawley* (President) in the Chair, *Mr. Frederic Gaster*, F.R.Met.Soc., of the Meteorological Office, delivered a lecture on "Weather Forecasts and Storm Warnings: how they are prepared and made known," which was illustrated by numerous instruments, diagrams, and lantern-slides.

Mr. Gaster said that in the preparation of forecasts the position held by the barometer was so much more important than that of any other instrument, that its action must be fully comprehended if the rest of the work was to be at all clearly understood. The lecturer having fully explained this, referred to the use of a single isolated instrument, and showed how very much more information was afforded to the observer who could have telegraphed to him simultaneous observations from a large number of places scattered over a considerable area of the Earth's surface. The kind of variation in the distribution was dealt with, isobars were drawn, and the phenomena which they exhibit in the way of high- and low-pressure areas described. An explanation was given of the terms "cyclonic" and "anticyclonic," and the generally opposite characteristics of these two systems were referred to. Mr. Gaster next drew attention to the obvious importance of the variation in the weather over a given area caused by alterations in the position of the cyclonic and anticyclonic systems, and the importance of the fact that the former tended to move round the latter from left to right. This led to some remarks on the indications observed when disturbances were advancing towards our islands from different points. Attention was drawn to secondary systems, both of high and low pressure, the forms they assume, and their effect on the weather, which, but for their presence, would probably have accompanied their primaries; and the necessity for allowing for such systems in sending warnings to our coasts. The lecturer then remarked on the value of auxiliary information, such as is to be obtained from decided changes in the direction of the wind, sudden changes of temperature, the movements of clouds at different levels, observations made at high-level stations, and telegrams from the United States.

Mr. Gaster next explained how the information is made known to the public. Forecasts are issued by the Meteorological Office in the Daily Weather Report, and also communicated to the press, &c. Hay-harvest forecasts are issued to certain selected authorities, who circulate them as much as possible in their neighbourhood. Storm warnings are telegraphed to our coasts, with instructions to hoist the cone, point up when the gale is probable from northerly to easterly points, and point down when from southerly to westerly points. In conclusion, the lecturer drew attention to the marked improvement which had occurred in these warnings in recent years, and to some of the occurrences which from time to time caused failures.

Professor Brown's Lunar Theory *.

A VALUABLE contribution to gravitational astronomy has recently appeared in the shape of a treatise on the lunar theory by Professor E. W. Brown, of Haverford College, Pa., and formerly Fellow of Christ's College, Cambridge. We are glad to see that the author has followed Professor Forsyth in adopting a large octavo page with a dark blue cover, abandoning the red and the green usually associated with mathematical text-books.

In the preface the author states that the object of his book is to give the general principles underlying the various methods of treatment of the problem of the Moon's motion, and to explain those methods, and not, except in so far as it is necessary, to develop the formulæ. The more recent developments of astronomy, from the pure mathematician's point of view, such as may be found in Poincaré's 'Mécanique Céleste,' are also left on one side. The series that occur in the lunar theory have never been proved to be convergent, but experience shows that they are suitable for computing the Moon's position.

In the lunar theory it is usual to neglect the Moon's mass, and subsequently to apply a correction that removes the greater part of the error introduced by this important simplification: it is also usual to assume that the Sun describes an elliptic orbit round the Earth according to Kepler's laws. In his first chapter, devoted to Force Functions, Professor Brown examines these simplifications, and shows that after the correction has been applied, the outstanding error is very small. This result is an obvious one, but we are not aware that a numerical estimate of the residual error has ever been previously published. It should, however, be noted that, although the residual error is beyond the limits of observation, nevertheless it is large compared with many of the terms computed by the various lunar theorists. It must be borne in mind that to compute such terms may be an interesting mathematical exercise, but the work has no practical application.

In his second chapter, the author obtains the equations of motion in the forms required for the theories of de Pontécoulant, Laplace, and Hill. He also obtains the ten first integrals, which, as Bruns and Poincaré have shown, are all that exist if we limit ourselves to uniform algebraic or transcendental functions. It is in this chapter that a very pleasing feature of the book first forces itself upon the notice of the reader: we mean the large number of references given to other works, affording most valuable assistance to those who wish to go deeper into the subject.

The third chapter is devoted to elliptic motion, Bessel's functions being used in the expansions.

In the fourth chapter the idea of intermediate orbits is introduced. The methods of solution are classified under continued approximation and variation of arbitrary constants. A sketch is given of the manner in which some terms rise in importance on integration, a fact to which the immense labour involved in the lunar theory may be directly attributed. The chapter concludes with Clairaut's artifice, on the modification of the intermediate orbit, in order to express the observed fact of the motion of the node and apse.

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* 'A Treatise on the Lunar Theory,' by E. W. Brown, M.A., Professor of Applied Mathematics in Haverford College, Pennsylvania. Cambridge University Press. Royal 8vo. 15*s*.

In the fifth chapter the method of variation of arbitrary constants is introduced. Expressions are obtained for the variations of the usual six elements. By a change of variables, equations are then obtained in the form known as *canonical*, and in this connection some theorems of Hamilton's and Jacobi's are given. A sketch is given of Lagrange's method: Cayley's departure points and Jacobi's pseudo-elements are also introduced.

The sixth chapter deals with the development of the disturbing function in the different forms suitable for the different theories. This concludes what may be called the introduction, and the reader is now prepared for a detailed account of the various theories. De Pontécoulant's theory is first discussed. The terms in the complete development of the lunar coordinates can be arranged conveniently into groups. In each group the different terms contain the eccentricities, inclination, and parallax raised to the same power. In order to exhibit Pontécoulant's method more clearly, the author considers several groups of terms successively and in order of simplicity. He also pays very careful attention to the constants of integration. It is obvious, *à priori*, that on proceeding to a second or higher approximation, an opportunity must present itself of modifying the constants of integration in the lower approximations. It is often convenient to make use of this power to simplify certain expressions, but, whatever course is adopted, the process is equivalent to defining the arbitrary elements of the motion with an increase of precision comparable with the raised order of approximation. The discussion of the constants is a subject of great importance, and the author has wisely interpolated a separate chapter dealing with this question.

Next in order comes Delaunay's theory. The reader has obtained assistance in the previous theory from having the analysis, so to speak, broken up for him. No such help can be expected here, for Delaunay's theory stands by itself, an indivisible atom of a thousand quarto pages, in which the results of twenty years' labour are briefly indicated, the actual work being suppressed. The author is consequently obliged to confine himself to an explanation of the method; and here we notice several improvements upon the explanations of Delaunay, in particular, in the transformation from one canonical system to another.

If the length of Delaunay's algebraical calculations was appalling, the theory upon which Hansen's method rests is equally so. The original papers are scattered. One theorem of Hansen's has recently been the subject of a note by Professor Brown in the 'Monthly Notices.' In its simplified form it now forms Art. 214 of the book.

To the hardest of all theories now succeeds the simplest—that originated by Dr. Hill, and to developing which most of Professor Brown's own work has been directed. The underlying principle of the theory is the use of rectangular coordinates referred to rotating axes.

The last two chapters of the book are devoted to the briefest possible account of several other theories, and to the hitherto omitted disturbances due to the planets and the figure of the Earth. The secular acceleration of the mean motion is also briefly discussed. P. H. Cowell.

On the Error caused by Variations of Temperature in Astronomical Instruments.[*]

M. Cornu has recently called the attention of astronomers to the systematic errors caused by the non-uniformity of distribution of temperature in observing-rooms and in astronomical instruments. After reading this work the idea suggested itself to me to study the perturbing effect exercised upon the fundamental instruments of astronomy by the heat emanating from the usual lighting apparatus of a transit-circle room.

My investigation of this subject shows that the heat communicated to the telescopes from these sources alters their geometrical form, and is able to cause alterations of several seconds of arc in the measures. They confirm completely the statement of M. Cornu concerning the flexure and systematic torsions produced by the want of symmetry of the sources of heat.

The experiments were made at the Paris Observatory on the Gambey meridian circle [†] by a method founded on M. Fizeau's principle of interference fringes. This apparatus has enabled me to study in its smallest details the movement of the telescope tube in the neighbourhood of the object-glass and around the micrometer during the heating produced by a radiating source and during the cooling.

The result of these experiments is that a lamp placed to the right or to the left of the telescope at different distances from the optical axis makes the collimation vary by quantities in inverse ratio to the square of the distance. The rate of deformation of the instrument decreases rapidly with the time during the warming. The flexure reaches half of its full value when the heating has acted for about two minutes. The effect is nearly at a maximum at the end of ten minutes. The phenomena then repeat themselves in inverse order during cooling.

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[*] Translated from 'Comptes Rendus,' tome cxxii. no. 11, March 11, 1896.

[†] This instrument is made of brass. It has a focal length of $2^{\mathrm{m}}\cdot10$ and aperture $0^{\mathrm{m}}\cdot16$.

Here are the perturbing effects produced by different radiating sources placed at a distance of a metre from the instrument during ten minutes:—

A gas-jet burning 250 litres an hour causes a variation of collimation ……………………………	1″·5 *
An oil-lamp with a double current of air consuming 31 gr. per hour ……………………………	0″·5
A petroleum lamp consuming 34 gr. per hour ………	0″·7

I have also sought to estimate the order of magnitude of errors produced by the heat emanating from the observer himself. I came to the conclusion that the presence of the astronomer beside his instrument was able to cause errors of several tenths of seconds of arc in the determination. One should not therefore neglect, *à priori*, the disturbing effect of the observer in researches of high precision.

These experiments have been conducted in view of observations of right ascension. There are, no doubt, analogous effects produced in the determination of polar distances.

The lights have a small effect upon the stone piers of instruments at a distance greater than one metre. But one ought not to assume the fixity of a pier submitted for several hours to the rays of a lamp placed at some decimetres only from the surface. Remembering this, it is quite inadvisable to fix gas-jets upon the supports of a meridian circle. The constants of an instrument installed in this way, such as the level, the azimuth, and the nadir, are sure to vary in the course of an evening.

MAURICE HAMY.

[This suggestion as to the cause of variation of some instrumental constants is not new, but M. Hamy's experiments are interesting as giving a direct determination of such variation. The magnitude of the observed variation of collimation is a little surprising. We believe that special precautions are taken at some observatories to guard against the effects of heating from the observer's body.—EDS.]

Selenographical Notes.

GAY-LUSSAC AND THE RILLS OF THE CARPATHIANS.—This irregularly shaped formation presents at first view no very attractive features. The border, except at two places on the north, is extremely narrow and low, and, unless examined with high powers under good definition, the level interior appears to be devoid of any details which can be clearly distinguished. Schröter doubtfully glimpsed two or three little objects, apparently hills, near the centre, Mädler some low mounds, and Neison a central crater and a few ridges. In the 'Astronomical Register' for July, 1883, I drew attention to the existence of two delicate but distinct parallel clefts on the floor, both of which, at $8^h\ 30^m$ on May 16 of that year, were seen to be associated with elongated depressions, nearly central, and the more easterly was traced beyond the wall on to the plain north of the formation. Schmidt shows nothing of either of these objects, but draws a large crater where the more westerly of the elongated depressions stands, and a row of four craters on the site of the other cleft.

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* This result has been verified by a mark. A gas-jet enclosed in a glass chimney consuming 200 litres an hour produced a perturbing effect three times as large. Lamps of this kind affect instruments at a great distance.

Between $6^h\ 45^m$ and $7^h\ 30^m$ on February 23 (one of the few tolerably favourable nights for lunar observation which we have had here for some time past), the clefts just mentioned with the two central depressions were well seen with a power of 340, and, in addition, a third, nearly parallel to them, lying further towards the east. Of these objects the most westerly (1) apparently originates at a nearly central elongated oval depression and runs up to the north wall, the central cleft (2) was traced from the northern rim of the crater standing between Gay-Lussac and Gay-Lussac *a*, through a somewhat larger but similar depression, almost exactly central, up to the north wall, which I am almost certain it traverses,—at any rate its direction is continued beyond as a coarse cleft which enters into a deep wide chasm, some miles in length. Issuing from the northern end of this it swerves slightly towards the west and runs up the eastern flanks of the great mountain mass connected with the north-western side of Gay-Lussac—this portion of it answering to Neison's rill *ε*. Immediately outside the north-west corner of the border of Gay-Lussac stands a dark crater of considerable size, from which a short rill runs, connecting it with the chasm. The other cleft (3) on the floor is shallow and was difficult to trace. As just remarked, it runs nearly parallel to the others, but only extends over about two-thirds of the northern part of the enclosure. Schmidt shows a valley between low hills on the site, but this object has all the appearance of being a true cleft.

The valley shown by Neison as extending from the eastern side of Gay-Lussac to a point near the end of one of the long branching arms of the Carpathians, marked *η* in his map, also appears to me to be a somewhat coarse cleft-like furrow, and not a valley. I noted one conspicuous little crater upon it, at a point about two-thirds of its length from Gay-Lussac, and a deep circular pit at its eastern termination under the cliffs of the Carpathians. From the more easterly of two small craters, just beyond the eastern wall of Gay-Lussac, I detected a very delicate unrecorded cleft extending in an approximately straight course, making an angle of about 30°

with η, to the region north-east of Copernicus. It was held steadily with 340 and was traced through the innumerable low radiating ridges and humpy swellings which abound in this region as a dark line of extreme tenuity without indications anywhere of an illuminated flank.

The serpentine cleft running south from the side of Gay-Lussac a up to the north *glacis* of Copernicus was an easy object. This was first recorded by Lieut. P. B. Molesworth, R.E., 1892, December 28, and from the drawing he forwarded to me it would almost appear to be a southerly extension of the central rill (2) mentioned above.

At the western foot of the mountain mass connected with the north-western side of Gay-Lussac there is a long deep valley, not shown in the maps, and further towards the west, commencing at an isolated mountain, a rill (of which Neison only shows a short portion, ϕ), which, sweeping round the Gay-Lussac region in a bold curve, and passing between two conspicuous craters situated close to a projecting mountain spur of the Carpathians, ultimately joins Molesworth's serpentine cleft at a point about midway between Gay-Lussac a and the north wall of Copernicus. There is no trace of this extension of ϕ in the maps, nor of two other objects, suspiciously resembling clefts, which, originating under the west wall of Gay-Lussac a, curve round towards the mountain mass north-west of Gay-Lussac, the more westerly stopping at a bright isolated hill aligning with the two conspicuous craters just mentioned.

A few miles due east of Gay Lussac a there is a dark oval spot, apparently about five or six miles in greatest diameter, without any rim, though its borders are very sharply defined.

Beaumont House, Shakespeare Road,
Bedford, 1896, March 19.

T. Gwyn Elger.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

An Old Writer on the Light received by the Superior Planets.

Gentlemen,—

Probably not many of your readers have seen a little volume published by the Rev. P. Parsons in 1774, under the title "Astronomic Doubts, or an Enquiry into the nature of that supply of light and heat which the superior planets may be supposed to enjoy." I may remark that the writer was also the author of several other works, particularly of one describing the monuments and painted glass in more than a hundred churches, most of them in East Kent *; but that of which I am speaking, written in the very year in which Herschel's first recorded observation was made, was the only one touching upon astronomy. Although some of his ideas are not destitute of sagacity, the confusion of thought is so remarkable that it will perhaps entertain your readers. After remarking on the unprofitableness of speculations on the possible differently constituted inhabitants of Venus or Saturn to adapt their eyes and bodies to the greater and smaller supplies of solar light and heat which they receive in comparison with our own, he points out (what seems, indeed, to have occurred to few at that time) that the satellites of Jupiter and Saturn cannot in any way compensate those planets for their deficiency of sunlight, simply because they themselves, like their primaries, are so much further from its source that they can only reflect but a very feeble amount of light compared with that which our Moon does. Strangely enough, he mentions as an objection to this that those satellites come at times nearer to the Sun than the planets round which they circulate, and does not see that the proportionally smaller distances are so slight that this can make no real difference in the argument; but he thinks it sufficient to reply that when they are thus nearer the Sun they are turning their unilluminated portions to their primaries. The habitability of the planets, however, is a point, he thinks, which cannot be given up; so he proceeds to suggest a means by which the more distant ones may acquire what he considers to be the requisite amount of light. This he finds in their greater proximity to the fixed stars, which he supposes will more than make up to them for their greater distance from the Sun! Of course in those days the actual distance of no fixed star was known even approximately, but it was known that the distance of even the nearest must exceed many times the dimensions of the solar system, so that the fact of Jupiter or Saturn coming nearer any of the fixed stars could not make any appreciable difference in the amount of light received. But even if not so, as he thinks the additional light comes from the multitude of stars in all directions, it is odd that he does not perceive that if Jupiter or Saturn approach some more nearly than we do, that very fact must take them further from others equally luminous. He falls, in fact, into the same confusion of thought spoken of above, when apparently thinking that the satellites of Jupiter and Saturn sometimes receive appreciably more sunlight than those planets themselves. Yet this does not arise from "ignorance, pure ignorance." The objection, he tells us, was before him, "that such is the immense distance of the fixed stars, that the nearest approach towards them, within the compass of our planetary system, and indeed much beyond it, would make no difference in their size and lustre." But this idea only arises, he thinks, "from a strong affectation to elevate and surprise. Philosophers, not contented with that noble scene of power and magnificence which a rational view of the works of nature will afford us, affect to magnify appearances beyond all reasonable extent, in order to raise our wonder, not merely at the scene of Nature, but at their own abilities, which could frame such great calculations; surely, however, such wonder must be offered with a *foolish face of praise*, when it is made to appear that this account, under a semblance of exalting the works of nature, only drives them headlong into absurdities." By "absurdity" he seems to mean denying that nearer approach will increase apparent size, which of course no one supposes, only that it can do so in any *appreciable* degree when the proportional proximity to the whole distance is so small as to be almost infinitesimal. But the author fancies he has another string to his bow and fails to perceive that the same objection still applies. If the greater proximity of Jupiter and Saturn does not appreciably increase the apparent size of the fixed stars, it must at least, he fancies, greatly increase the *number* of those visible to the naked eye, and so produce the desired effect of greater light in another way.

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* A large part of the impression of this was destroyed in a fire.

Yours faithfully,

Blackheath, 1896, Mar. 2. W. T. LYNN.

New Variable Orange Stars.

GENTLEMEN,—

I have to announce the variability of Birmingham 502, R.A. $19^h\ 25^m\ 28^s$, D. $+76°\ 19'$ (1890), in Draco, and of Espin-Birmingham 264 *a*, R.A. $8^h\ 14^m\ 21^s$, D. $+3°\ 7'$ (1890), in Hydra. The former varies slowly, through perhaps a magnitude; the latter's variation is more. Their colours are, respectively, deep orange-red and deep reddish orange; but the star in Hydra is now too faint to show any colour distinctly in my telescope—a 4¼-inch refractor. The Bonn magnitudes are 6·5 and 8·3 (respectively).

It has often been pointed out that the magnitude of a deeply coloured star is more difficult to observe than that of others; but when the comparisons are made under the same conditions the difficulty is much reduced, so that I have no hesitation in saying that the two above-mentioned stars are variable. Mr. P. S. Yendell, in No. 321 of the 'Astronomical Journal,' calls attention to the difficulty in a case, that of U Camelopardalis (Chandler's No. 1279), which is certainly very remarkable; for he says that Dr. Hartwig made the star to be increasing in brightness at the same time as he, himself, made it stationary. I would point out, however, that though this is very curious, it is quite possible to reconcile the observations of the two observers by assuming that the change in brightness was only one-half as great as Hartwig made it, and that there is a difference of 0·9 magnitude between the standards of the two observers. On these suppositions, none of the observations so far as recorded in that article need be as much as ¼ magnitude from the truth; and this would probably not be considered too large an error in the case of a deep orange star. The assumed difference between the two standards, viz. 0·9 magnitude, is a large one, but I do not know whether there are any other observations to contradict such a supposition; and it is certainly not an impossible difference.

Yours faithfully,
Sunderland, 1896, March 20. T. W. BACKHOUSE.

Rotation of Venus. Naked-eye Views of Mercury. Spots on Saturn.

GENTLEMEN,—

There are several points in the papers published under the above titles in No. 238 which induce me to make several remarks. First, I am reproached for giving the rotation period of Venus to the fourth decimal of a second. If you will look into No. 1592 of the 'English Mechanic' you will find how I got this number. I said: "Computation gave an hourly advance (of the preceding end of the Mare Italicum) of 15°·030, which would correspond with a rotation period of $23^h\ 57^m\ 7^s{\cdot}5459$." You see, that the given number is only the *mathematical* equivalent of the discovered rate of advance of the spots; therefore I was obliged to give the exact number. That I did not pretend to have found the real rotation period to the fourth decimal of a second, is proved by my remark (quoted by yourselves) that this number cannot differ from the real period by one second.

Concerning Mr. Denning's letter on naked-eye views of Mercury, it will perhaps interest you to hear that this planet is an *easy* naked-eye object from our island whenever he reaches his greatest elongations. Sometimes he is so brilliant that some peoplet take him for Venus! That seems to depend on the transparency of our air, which may, perhaps, account for the fact, too, that the Zodiacal Light is here so conspicuous a phenomenon. Very often it surpasses the Milky Way 5, 8, and even 10 times in brightness!

The spots on Saturn—dark and bright ones—were seen by me with the greatest certainty 8 or 9 times in the year 1894, as you will learn from a paper of mine in one of the next numbers of the Astronom. Nach. Last year I sometimes saw that mottled aspect of the belt which betrays the presence of spots, but owing to bad air and, particularly, to the low declination, I was not able to distinguish the single spots. LEO BRENNER.

Manora-Sternwarte,
Lussinpiccolo (Istrien).

[We are sorry that Herr Brenner should have taken our small pleasantry seriously as a "reproach." We are, however, certainly of opinion that it is ill-judged to publish a numerical result to the fourth place, when the observation on which it depends may be in error by a quantity corresponding to the unit place. Herr Brenner's remark on the Zodiacal Light comes opportunely, remembering the discussion at the R.A.S. Meeting reported in this number.—EDS.]

OBSERVATORIES.

The Yerkes Observatory.—A notice in the 'Astrophysical Journal' for March, which forms No. 1 of a contemplated series of Bulletins to be issued from this institution, gives in some detail the present state of things relative to the Yerkes Observatory.

"The Yerkes Observatory was founded in 1892 through the munificence of Mr. Charles T. Yerkes, of Chicago. In that year, Mr. Alvan G. Clark undertook the construction of an object-glass of forty inches aperture for the principal telescope of the Observatory, and Messrs. Warner and Swasey were given a contract for the equatorial mounting. The latter was completed in the following year, and exhibited by its makers at the Columbian Exposition. It is similar to the mounting of the 36-inch Lick telescope, but is heavier and more rigid, and many improvements have been introduced. An important feature, long ago suggested by Grubb and others, but apparently employed for the first time in this telescope, is a system of electric motors, by means of which the various motions, etc. are effected. The object-glass has recently been tested by Prof. James E. Keeler, who acted at the request of the Director as the 'expert agent' called for by the contract. The definition was found to be equal to that of the Lick telescope, while the light-gathering power is considerably greater.

"The attachments of the Yerkes telescope will include:—

" 1. A position-micrometer by Warner and Swasey.

" 2. A solar spectrograph for micrometrical and photographic investigations of the spectra of solar phenomena.

" 3. A spectroheliograph for photographing the solar chromosphere, prominences, and faculæ by monochromatic light.

" 4. A stellar spectrograph for researches on the spectra and motions of stars, nebulæ, comets, and planets.

" 5. A photoheliograph of great focal length for photographing the direct solar image on a large scale.

"The construction of the main building of the Observatory was begun in April 1895. After many delays it is now under roof, and will be completed in the summer of 1896. Its form is that of a Roman cross, with three domes and a meridian room at the extremities. The principal axis of the building (about 330 feet long) lies east and west, with the dome for the 40-inch telescope at the western end. This dome, which will soon be erected by Messrs. Warner and Swasey, is 90 feet in diameter, allowing ample space for the tube of the great telescope, which, with its attachments, is about 75 feet long. The elevating-floor of the observing-room is 75 feet in diameter, and will be movable through a range of 22 feet by means of electric motors."

The staff of the Observatory consists of:—G. E. Hale, Director, S. W. Burnham, E. E. Barnard; and F. L. O. Wadsworth, T. J. J. See, and Kurt Laves, who will act as instructors, for the programme comprises instruction to students in connection with the courses of the University of Chicago; G. W. Ritchey, optician; E. Kandler and W. Gaertner, mechanicians. These last-named gentlemen have place in the organization, because a special feature of the institution is to be the well-equipped workshops, where it is proposed to do the optical work and make the instruments necessary for the Observatory.

The Observatory is situated about a mile from the town of Williams Bay, near Lake Geneva, Wisconsin, an ideal rural region, where it is thought the conditions will be favourable for the most delicate investigations in all branches of astronomy and astrophysics. We believe that the opening ceremony will take place in the course of the forthcoming summer or autumn, and it is possible, therefore, that some European astronomers, who may be coming home through America after observing the Solar Eclipse, may be present.

PUBLICATIONS.

Australian Longitudes.—We have lately received a reprint of a paper read by Mr. Pietro Baracchi, the recently appointed Director of the Melbourne Observatory, before the Australasian Association for the Advancement of Science, on "the Most Probable Value and Error of Australian Longitudes, including that of the boundary lines of South Australia with Victoria and New South Wales." This is of considerable interest for several reasons, not the least being that the comparisons of different determined values of the same arcs point out the magnitude of errors to be expected in longitude determinations, and Mr. Baracchi, who has had considerable practical experience in this kind of work, points out reasons which may lead to such errors, and are therefore to be guarded against. The first part of the paper is a discussion of the values of the longitude of Madras, giving the results and circumstances of each arc which go to make up the two chains joining Madras and Greenwich. We indicated the course of these chains in a brief historical note in our number of last September. Mr. Baracchi has modified the results there given by including Dr. Gill's determinations at Aden and the arc Kurrachee—Madras determined by officers of the Indian Survey, and thus finds results for the longitude of Madras:—

$5^h\ 20^m\ 59^s{\cdot}275 \pm 0{\cdot}139$ *viá* Suez—Aden—Bombay.
$5\ \ 20\ \ 59{\cdot}430$ *viá* Ispahan—Kurrachee.

Next follows the description of the arcs connecting Madras with the Australian Observatories, the details of which we need not repeat here; but there is an interesting page giving the longitude of Sydney, determined by method of moon-culminations and by lunar occultations, side by side with the telegraphic determinations. The accordance of these figures is rather remarkable.

It must be noted, however, that the longitudes by lunar observations are each the mean of several determinations made at various places, from which the result for Sydney is deduced by applying adopted values of differences of longitude.

Longitude of Sydney by culminations $10^{h}\ 4^{m}\ 49^{s}{\cdot}16$ E.
" " occultations 10 4 50·32 E.

And giving weights to these determnations:

Longitude of Sydney by absolute methods $10^{h}\ 4^{m}\ 49^{s}{\cdot}93 \pm 0{\cdot}581$.
" " telegraphic method 10 4 49 $39 \pm 0{\cdot}182$.

The latter part of the paper is taken up by a discussion of the accuracy of the boundary-lines laid down between South Australia and the adjacent colonies of Victoria and New South Wales, which is defined as the 141st meridian east of Greenwich. The boundary-line between South Australia and Victoria was laid down by triangulation methods depending on the longitude of the Paramatta Observatory. The boundary-line between South Australia and New South Wales depends on the determination of the longitude of a point near the 141st meridian, which passes between Sydney and Melbourne, the arcs being measured which connect this point with both those observatories. This determination was made by Mr. (now Sir Charles) Todd in 1868, and the result was received with some confidence, as the whole arc Sydney—Melbourne was measured directly, and the circuit error came out as $0^{s}{\cdot}14$. Mr. Baracchi now finds that Mr. Todd's arcs do not agree with the value Sydney—Melbourne found in the earlier part of his paper, but show a discordance of $0^{s}{\cdot}55$, and hence that the adopted boundaries between these colonies differ considerably from that defined by legal enactment.

Mr. Baracchi has written his paper in an evidently judicial spirit. He indicates weak links in the chain to show that the longitude of the Australian observatories, measured from Greenwich, can hardly be said to be known within a second of time. With the following passage, in which he points out that the accuracy of a longitude determination is *not* to be measured by its mathematical probable error, we are certainly disposed to agree:—

"The theoretical errors attached to the longitudes of Adelaide, Melbourne, and Sydney, found above, are respectively ±0·157 sec., ±0·158 sec., and ±0·182 sec. It has already been stated that these errors represent only that part of the probable uncertainty due to the disagreement of separate results of the same measure derived from each night's work, when compared with their mean value. It would appear then that the really and purely accidental errors incurred in each single night of the period upon which a longitude result depends are fairly measured by the theoretical errors; or, if this measure is not quite satisfactory, is at least the best that can be obtained. But there may be involved systematic errors common to all the nights of that period, some of which are beyond the reach of investigation, and others that might possibly be discovered only by delicate and continued experiments in fixed institutions, but not in the temporarily arranged longitude observatories.

"Altered personal equations at each new place of observation, instrumental changes, flexure, physical peculiarities of the localities, and many other known and unknown causes may bring in systematic errors not easily discovered. The theoretical error has no concern in these matters, and gives no help. It is when new instruments and new observers are employed in different years, so as to make the redeterminations entirely independent, that the existence of these systematic errors is revealed, if the results do not agree. But even then it is difficult, if not sometimes impossible, to locate them. There are, besides, inaccuracies, the causes of which are traceable, such as unsteadiness of stations, imperfect adjustment of electric instruments, changeable strength of circuits, level imperfections, unfavourable conditions such as having to carry time-pieces to a distance, and others; but their effect can only be made evident by new measurements.

"Every determination of differential longitude, however short the interval may be, is weakened by at least some of the causes here enumerated."

HISTORICAL AND FUTURE ECLIPSES. By the REV. S. J. JOHNSON, M.A., F.R.A.S. (London: James Parker and Co.)—Mr. Johnson's well-known little book 'Eclipses Past and Future' appeared in 1874. In 1889 he brought out a second little work, 'Eclipses and Transits in Future Years,' which gave a list of the more important Solar Eclipses and of the Transits of Mercury and Venus visible in this country up to the year 2498, lunar eclipses being given up to the year 2000. The present volume is a combination of the two. The interesting account of the eclipses of antiquity and of the middle ages is practically reprinted from 'Eclipses Past and Future'; there are, however, a few alterations and additions, and the work is brought up to date by some description of recent eclipses, including that of April 1893. With reference to future eclipses, we regard the new work as decidedly inferior to its predecessor. The former gave most useful and interesting particulars of the more important European eclipses of the next half-century, which are greatly abbreviated and in some cases entirely omitted in the present volume. We are quite at a loss to understand why, in a work published in 1896, the catalogue of future eclipses should commence with the year 1902, especially as there are four important solar eclipses in the interim (those of 1896, 1898, 1900, 1901). The first three of these are casually mentioned in a parenthesis, but without any details, and all reference is omitted to the lunar eclipses of the period. It certainly seems singular that, as these eclipses draw nearer, particulars concerning them should grow more meagre.

From 1902 onward the work is practically a reprint of 'Eclipses and Transits in Future Years.' The latter work contained diagrams of eclipses visible in England up to 1949; these are repeated here, with the addition of some picturesque embellishments intended to readily distinguish solar from lunar eclipses; they have been considerably extended, all lunar eclipses being illustrated up to 2000, and the more important solar ones up to 2491.

It is pointed out that there will be seven eclipses (the highest possible number) in each of the years 1917, 1935. This has not happened since 1805.

We notice a singular erratum on page 87. Referring to Oppolzer's 'Canon der Finsternisse,' the author says: "This gives all solar and lunar eclipses, *except solar ones in the southern hemisphere*, from B.C. 1207 to A.D. 2161." It is scarcely necessary to point out that the 'Canon' contains all solar eclipses visible from any point of the Earth. The diagrams, however, do not include those eclipses whose central lines lie wholly to the south of latitude 30° South.

'Eclipses Past and Future' contained also "Hints for observing the heavens," being an account of the principal facts known concerning the Sun, Moon, and planets, and details concerning the more remarkable double stars and other objects of interest in the constellations. This is repeated without material alteration, and is likely to be of great utility to the possessors of small instruments. Many of the facts and observations here collected are of great interest, but in a few instances some rather trivial matters have been inserted which we think might well have been omitted. We may refer in particular to the rules connecting the weather with the changes of the Moon which are given on page 124.

The work as a whole, however, is a distinctly interesting and valuable one, and we recommend those of our readers who do not possess the older edition to obtain a copy of it. A. C. D. C.

DRESDEN (D'ENGELHARDT OBSERVATORY) ASTRONOMICAL OBSERVATIONS, Part III.—It has been remarked of the amateur astronomer that as soon as he has mounted his *large* telescope he has dismounted from his hobby. There may be some truth in this, for it is not difficult to name instances of men who have enjoyed making a big telescope rather than doing work with it, but the aphorism certainly does not apply to the Baron d'Engelhardt of Dresden. In 1879 he built a large observatory, having previously occupied a smaller one, and installed therein a 12-inch equatorial by Grubb, with a Repsold micrometer and other accessories of a well-equipped observatory. Since that time he has used this instrument to some purpose, and the third volume of his observations published last year (we regret that it has lain on our table so long) is now before us.

Baron d'Engelhardt's observations have chiefly been micrometer measures of stars, whose annual proper motion is 0″·1 or less, for determination of such proper motion. In the second volume the measures of 829 stars from Bradley's Catalogue were published. This third part gives the results of the re-observation of some 55 of these stars and also of many stars from the list given by Dr. Oscar Stumpe in Ast. Nach. no. 2999–3000, which were used in his research on the proper motion of stellar systems.

We have mentioned these observations first, although they come last in the book, as this seems to be the work to which Baron d'Engelhardt has chiefly devoted himself; but a large part of the volume is occupied by the results of micrometer measures of the positions of nebulæ and stellar clusters, with a catalogue deduced from the observations given not only in this part but also in Parts I. and II. of the publications of this observatory. The catalogue comprises the positions of nearly 300 of these objects for epoch 1885 with precessions, the corresponding numbers in the New General Catalogue being added, and also the number of nights of observation, and a reference to the star place on which the catalogue place of the nebula depends. These are two magnificent pieces of work of which any observatory might be proud, but, besides, there are collected in this volume records of many observations of a more occasional character: the occultation of Jupiter and his two satellites by the Moon on 1889, August 7; the Transit of Mercury, 1891 May 9; observations of position of Nova Aurigæ, and also of many comets, from Barnard's Comet of 1888 to Comet 1894 II. (Gale). The results of all these have been published in 'Astronomische Nachrichten' at various dates. The whole of these observations are given in a delightfully clear and intelligible manner, the printing is excellent and the binding is worthy of its contents.

NOTES.

Comet Notes.—Faye's Comet was under observation with the 26-inch refractor of the U.S. Naval Observatory, Washington, up to Jan. 15 last. On the latter day it was described as very distinct with decided central condensation, its diameter being 30″.

Perrine's first comet was fairly conspicuous up to the end of February, and numerous observations are reported. Ast. Nach. 3339 gives an account of a naked-eye observation of this comet made in South Africa on Dec. 21, the observer being unaware of its previous discovery. It was seen almost immediately after sunset, and had a tail ½° in length.

The comet should be still visible in April, though somewhat faint. The following ephemeris is for Berlin midnight:—

	R.A.			N. Dec.			R.A.			N. Dec.	
	h	m	s	°	′		h	m	s	°	′
Mar. 24....	19	41	3	8	36	Apr. 25....	19	8	58	17	32
Apr. 1....	19	36	0	10	53	May 3....	18	55	49	19	30
9....	19	29	3	13	10	11....	18	40	50	21	11
17....	19	20	4	15	24	19....	18	24	26	22	32

Comet Perrine-Lamp was very conspicuous early in March, and numerous observations are reported. The following elements are by Dr. Lamp from a large number of observations, ranging from Feb. 15–22:—

T = 1896 Jan. 31·79848 Berlin M.T.

$$\left.\begin{array}{ll} \omega \;\ldots\ldots\ldots & 358^\circ\ 20' \\ \Omega \;\ldots\ldots\ldots & 208\ \ 53 \\ i \;\ldots\ldots\ldots\ldots & 155\ \ 47 \end{array}\right\} 1896{\cdot}0.$$

$\log q \;\ldots\ldots\; 9{\cdot}76874$

Almost identical elements have been deduced by Dr. Chandler (Ast. Journ. 367).

The following ephemeris is for Berlin midnight:—

	R.A.			N. Dec.			R.A.			N. Dec.	
	h	m	s	°	′		h	m	s	°	′
Apr. 3....	4	19	25	42	5	Apr. 27....	4	53	59	39	29
9....	4	29	45	41	11	May 3....	5	0	52	39	8
15....	4	38	39	40	28	9....	5	7	23	38	52
21....	4	46	39	39	55						

On May 9 the brightness is $\frac{1}{250}$ of that at discovery.

Numerous photographs of both the above comets were obtained at Prague in February. The first showed a stellar nucleus of about the 10th magnitude and a tail some 2° in length. The second comet appeared on Feb. 15 on the same plate as the first. On Feb. 22 a conspicuous tail $2\frac{1}{2}$° long was shown, divided in the middle by a dark streak. The northern half was the brighter. The nucleus was well defined, of the 7th or 8th magnitude. (Ast. Nach. 3340.)

It appears that the Kiel telegram announcing the rediscovery of Perrine's first comet was erroneously transmitted to Mount Hamilton. It was hence concluded that the object observed was new, and the mistake led to the discovery of the new comet—'certainly a most singular and fortunate coincidence.

The following is a continuation of the search ephemeris for Comet 1889 V. (Brooks):—

	R.A.		S. Dec.			R.A.		S. Dec.	
	h	m	°	′		h	m	°	′
Apr. 2....	20	40	24	9	Apr. 26....	21	19	22	12
10....	20	54	23	31	May 4....	21	31	21	33
18....	21	6	22	52					

A. C. D. C.

MINOR PLANET NOTES.—M. Coniel investigates, in the 'Bulletin Astronomique' for February, the elements of No. 391. As the orbit of this planet is of exceptional interest, making the closest approach to the Earth of any of the group, we give the elements in full:—

Epoch 1894 Dec. 20·5 Paris M.T. Equinox 1894·0.

M	35° 58′·9	π	357° 46′·3
ϕ	17 58·0	☊	212 35·9
μ	1003″·916	i	23 3·0

The opposition of 1894 was near the perihelion of the planet, and it was of the 10th magnitude. In the present opposition it is only of about the 15th.

Mr. G. W. Hill gives in Ast. Journ., No. 368, an investigation of the orbit of Ceres from the observations of ten oppositions ranging from 1802 to 1890. The perturbations by Jupiter are completely investigated as far as the first order of small quantities, and the secular perturbations by Saturn and Mars are applied. He deduces the following elements:—

Epoch 1850 Jan. 0^d·0 Greenwich M.T.

L=	309° 30′ 32″·4	
π=	148 28 32·5	+106″·6658 t
☊=	80 48 5·6	− 4·9064 t
i=	10 37 6·2	− 0·5676 t
e=	0·07844855	−0·0000033347 t
μ=	770·718276	
log a=	0·4420738	

On comparing the observed places with those deduced from this orbit some rather large residuals appear. The method, however, does not profess to be an absolutely rigorous one.

A. C. D. C.

THE EFFECT OF BAROMETER PRESSURE ON THE RATE OF A CLOCK.—M. Tisserand has been making some researches on this subject, using as data the rates shown by the normal mean-time clock of the Paris Observatory. The tables in his paper, which is printed in the 'Comptes Rendus' for March 11, make it rather too long to reproduce in full here, but the following details may be found of interest.

This clock is set up in a cellar at a depth of 27^m, where its temperature remains practically invariable throughout the year; the variation is not more than 0°·02 C. Although the clock-case is hermetically sealed, its interior is evidently susceptible to the same variation of barometer pressure as the external air, as will be seen from the investigation now described. M. Tisserand's first table gives the daily clock-rate for certain periods between 1894 August and 1895 January, determined from star observations. These daily rates, which vary from $+0^{\mathrm{s}}.23$ to $-0^{\mathrm{s}}.16$, are at first sight remarkable only for their capriciousness, a rate of $+0^{\mathrm{s}}.19$ being followed by one of $-0^{\mathrm{s}}.01$ and that by $+0^{\mathrm{s}}.20$, which are the observed clock-rates in October and November. But when side by side with the rate is given the mean barometer pressure during the periods to which they correspond, the summation of the barometer pressure being effected graphically from the sheets of the recording barograph, a reason for this irregularity is at once apparent. In a table the clock-rates are collected in order of ascending barometer readings. To the lowest barometer reading, 740^{mm}, the rate corresponding is $-0^{\mathrm{s}}.16$, and to the highest, 766^{mm}, the rate is $+0^{\mathrm{s}}.21$. The other rates and pressures lie quite uniformly between these extremes, so that the rate may be represented by the formula

$$0^{\mathrm{s}}.019+0^{\mathrm{s}}.0146\,(\varpi-753^{\mathrm{mm}}),$$

where ϖ is the mean barometer reading during the period covered by the rate. Comparison of the actually determined rates with this formula give residuals in no case larger than $0^{\mathrm{s}}.02$. M. Tisserand points out, strangely enough, that if the coefficient of the variable term were determined theoretically from consideration of the variation of pressure of air upon the pendulum, the resistance and friction of the air, &c., the value found theoretically would be identically that found from experiment as above, $0^{\mathrm{s}}.0146$.

M. Tisserand has then gone on to examine how well the clock correction at any epoch could be represented by a formula—

$$Cp=a+b(t-\tau)+c(t-\tau)^2+\sigma\int p\,dt,$$

where Cp is the clock error at time t, τ is the mean epoch of the observations above mentioned, $\int p\,dt$ is the barometer at the time t, and a, b, c, σ are unknown, which are found by comparing this formula with values of Cp determined on each of 43 days; and thus forming equations, the solution of these gives as the value for σ the coefficient of the barometer correction $0^{\mathrm{s}}.0140$, which, we are told in a footnote, is the exact value used by M. Bakhuyzen, Director of the Leyden Observatory, to compute the correction to his mercurial pendulum. b is found to be $+0^{\mathrm{s}}.0616$ and $c=-0^{\mathrm{s}}.000161$. A final table compares the clock errors determined on 43 days from observation with the error as computed by the above formula, first using the complete formula, including the term depending on the barometer, and then with the term omitted. The comparison shows that the first hypothesis is very much more in accord with the facts; the accordance is indeed remarkable. It appears that at any time during the 143 days covered by the observations the clock error could have been computed by this formula, with the barometer reading as datum, and never been in error by more than $0^{\mathrm{s}}.3$; and, in fact, for a period of six weeks in November and December the computed clock error would have agreed with the observed within about one-tenth of a second, except on one occasion, when it may very well be that the observation is at fault.

THE FIFTH SATELLITE OF JUPITER.—"On account of the opposition of Jupiter in 1894 falling in the bad season for observation at Mount Hamilton—and that season being an especially bad one—a few measures only of the Fifth Satellite were obtained. In but one instance was it possible to cover the elongation-time."

This is the opening paragraph of the article in Ast. Journ., No. 367, in which Prof. Barnard gives his observations of the satellite in the year 1894. He managed to make observations, although with difficulty, on 8 nights between Oct. 8 and Dec. 3, the observations consisting of measures of distances made with the filar micrometer in the direction parallel to Jupiter's belts. It may be remembered that Dr. Marth's ephemeris of this satellite, published in 'Monthly Notices,' vol. lv. p. 533—part of whch we have used in *The Companion* for this year—is based on Prof. Barnard's observations in 1893, as Dr. Marth considered that these 1894 observations, of which he had an advance copy, left the correction to the ephemeris rather uncertain. Prof. Barnard points out that his observations show the elongation on 1894 Dec. 3 to have happened a little over a minute of time later than was given by Dr. Marth, so that possibly the ephemeris may be about one minute too early. It would seem, however, that the adopted period, $11^h\ 57^m\ 22^s{\cdot}60$, will represent the motion of the satellite with sufficient closeness to find it for some years to come. Dr. Marth's apparent elongation-distance on 1894 Dec. 3 was $59''{\cdot}41$, with which Prof. Barnard's observation, $59''{\cdot}50$, closely agrees.

HARVARD COLLEGE CIRCULAR, NO. 6: NEW VARIABLE STARS.—An examination of the Henry Draper Memorial photographs of stellar spectra by Mrs. Fleming has led to the discovery of fourteen new variable stars of long period, in addition to those previously announced. The spectrum of the fifth star in the following list is of the fourth type. All of the others have spectra of the third type, having also the hydrogen lines bright, and it was this peculiarity which led to their discovery. The variability has been shown by comparison of a large number of photographs, and the variation has been confirmed in each case by Prof. E. C. Pickering. The following table gives the catalogue designation of the star, the approximate right ascension and declination for 1900, the photographic magnitude, when brightest and faintest as derived from these plates, and the period as obtained from the material now available. It is needless to caution astronomers that these elements cannot safely be used to predict future maxima with accuracy. They generally represent the photographic magnitudes during the last eight years, with an average deviation of one- or two-tenths of a unit. As, however, the periods and light curves in many cases change, the true law can be determined only from long series of observations. The date of the next maximum, as indicated by the formula, is given in the final column.

Designation.	R.A. 1900.	Dec. 1900.	Magn.		Period.	Maximum.
			Br.	Ft.		
	h m	° ′			days.	1896.
B.D. −39° 16 ..	0 3·6	−39 47	8·9	<12·1	295	May 25.
A.G.C. 6135	5 15·6	−33 48	7·6	11·3	225	June 23.
....	7 1·5	+ 9 1	10·3	<13·7	364	Sept. 11.
B.D. +5° 2708..	12 57·6	+ 5 43	8·8	9·7	......	......
....	14 59·3	−71 40	9·0	<11·4	......	......
B.D. −33° 13234	18 21·4	−33 23	8·2	12·3	316	July 2.
B.D. −19° 5347	19 8·1	−19 2	9·7	11·1	......	......
....	19 8·7	−18 59	9·9	<13·3	......	......
....	19 39·5	−72 1	7·6	12·1	243	Aug. 29.
A.G.C. 28038......	20 21·8	−28 35	7·4	8·4	......	......
....	20 47·2	−63 5	9·6	<12·3	......	......
B.D. −38° 15044	22 19·9	−38 4	8·6	11·0	......	......
....	22 19·9	−48 57	7·2	12·3	400	May 10.
B.D. −16° 6379	23 47·1	−16 25	8·2	9·3	......	......

Mr. Lynn sends us the following with reference to his letter on Herschel's observation of Saturn's Ring, which appeared in our last number:—Mr. Denning writes to me to point out that the word "list" used twice by W. Herschel in speaking of the division in Saturn's ring (Phil. Trans. 1792, p. 3 and 10) is not a misprint, as it originally meant a strip or border, though now the usual sense is a catalogue, derived from the other, as a list of names would be written on a strip of some material. What led me at first to think it a misprint was that in his earliest paper in the Phil. Trans. for 1790, Herschel uses no such expression; but after denying that the ring was subdivided by many such lines, "as has been represented in divers treatises of astronomy," he affirms that "there is one single, dark, considerably broad line, belt, or zone, upon the ring." But in the Phil. Trans. for 1792, whilst he usually calls it a dark or black division, he twice (as I said before) applies to it the term "black list." Halliwell, I may remark, quotes from Topsell's 'Historie of Serpents' (1608) a passage in which this word is used in almost the same way in which Herschel uses it, but which is surely now obsolete. Topsell speaks of a kind of worms "having a black list or line running along their backs."

Temperature and Sun-spots.—In some papers to the Société Astronomique de France, M. Flammarion is giving the annual temperature for twenty years at several of the principal cities of the world. He has been tempted to compare these temperatures for Paris with the sun-spot variation, although he, as might be expected, does not draw any conclusion from the comparison, because he is quite aware that while the temperatures of some cities follow those of Paris, others are equally opposed. But the curve of temperatures for Paris is certainly much like the corresponding sun-spot curve, as shown in a diagram in the current 'Bulletin' of the Société Astronomique.

THE ASTRONOMICAL AND PHYSICAL SOCIETY OF TORONTO.—The volume of Transactions of this Society recently to hand contains a miscellaneous collection of articles on astronomy of rather unequal value. The meetings of this Society appear to take place fortnightly throughout the year, summer included; and at each meeting, after short reports of the observations made by members since the last meeting of such things as meteors, planetary markings, and so forth, a prepared paper on some astronomical or kindred subject is read. Some of the subjects lectured upon in 1895 were: the spectra of the nebulæ, a very able paper by Mr. A. F. Miller; Celestial Photography, an interesting history by Mr. G. E. Lumsden; Saturn and the Nebular Hypothesis, a discourse by Mr. J. Phillips, in which he demolished Laplace's theory to his own complete satisfaction. There was another paper entitled "Historical Sketch of the Greenwich Nautical Almanac," which we read with a little disappointment. The few facts given are not new to us, though perhaps they may be to the Canadian Society; the author approached his subject in a somewhat comic vein, and suggested that the staff of the Nautical Almanac Office would form good material for character for the novelist. We commend this fancy to Dr. Downing. There was also among matters laid before the Society some notes by Mr. T. S. H. Shearmen, who claims to have discovered the principle of the Oblique Cassegrain, and also convinced himself of its possibility by experiments in the year 1878. Naturally there is given in the volume full reports relating to the Unification of Time, which is so much identified with Canada. This Society appears to be in a healthy and strong condition; we wish it continued success.

WE should like to call attention to an article in 'Knowledge' for the current month on the Spectrum of Helium, by Mr. E. W. Maunder. Written in this author's usual complete and lucid style, the essay will be found invaluable to any one who wishes to learn the history of this element, which has lately aroused such interest. Any attempt to make a *résumé* of this would do it injustice, but the paper itself is within easy reach.

Miss Catherine Bruce has presented the sum of one thousand dollars to the University of Chicago for the purpose of providing pictures for the 'Astrophysical Journal.' It may be remembered that the spectroscope lately constructed for the Newall Telescope at Cambridge is the gift of Miss Bruce, and that she has helped Astronomy by many such benefactions, both in America and England.

Dr. E. Lamp discusses, in the 'Astronomische Nachrichten,' No. 3343, the observations made at Kiel, in the Prime Vertical, for variations of latitude. The series extends from 1892 Aug. 15 to 1894 Jan. 14. He gives diagrams comparing the curves at Kiel and at Pulkova from observations during the same period.

Mr. Harold Jacoby, in the January issue of 'Popular Astronomy,' gives a short description and historical account of the Cape of Good Hope Observatory. He illustrates his article with photographs of the heliometer house, the heliometer, the main building, and a view at the entrance.

According to the London 'Standard' of March 30, the steamer 'Norse King' struck on a rock off the island of Zante and is seriously injured. The Eclipse party may congratulate themselves that she did not wait for the Norwegian voyage to have this mishap.

'Ciel et Terre' is responsible for the information that the discs, for the objective of the huge 60 metres telescope intended to be ready for the Paris Exhibition of 1900, have been successfully cast, and that each is insured for 100,000 francs.

From the same Journal we learn that at Paruschowitz, in Silesia, a boring of the Earth's crust to a depth of 2004 metres has been made. The total cost has been 94,000 francs. Thermometer readings show a very irregular increase with the depth. The mean is 1 degree for 34·14 metres.

Dr. Julius Bauschinger, Chief Assistant to Dr. Seeliger at the Munich Observatory, has been appointed to succeed the late Dr. Tietjen as Director of the Berlin 'Astronomischen Jahrbuch.'

We hear that M. Aristide Coumbary, the Director of the Imperial Meteorological and Seismological Observatory at Constantinople, is dead. M. Salih Zéky is appointed his successor.

From an Oxford Note-Book.

When a great man speaks deliberately on a great subject it is worth while to listen. Dr. G. W. Hill delivered on 1895 December 27 his Presidential Address before the American Mathematical Society, and styled it "Remarks on the Progress of Celestial

Mechanics since the middle of the Century." The reprint (which should be secured at once by every astronomical library; for such chances are easily lost) occupies twelve pages of about this size. After remarking that "a thoroughly satisfactory history of our subject is yet to be written; we have only either slight sketches of the whole, or elaborate treatments of special divisions of the science and none of them coming down to recent times," Dr. Hill proceeds to "touch very lightly the more important steps made since the middle of the century": and he considers especially the work of Delaunay, Gyldén, and Poincaré.

THE portions of the address which I found most interesting were Dr. Hill's remarks about Gyldén's work, which has always been something of a mystery to those who, like myself, have not time to follow it with any close attention. One of Gyldén's disciples, whom we had the good fortune to see at Greenwich some years ago, was enthusiastic about his work, and was kind enough to write an account of its general scope for this magazine*. The following paragraphs from Dr. Hill's address are of course taken from their context, and this may not be quite a fair proceeding; but, after all, these are only notes, and those interested can see the whole criticism with very little trouble in the 'Bulletin of the American Mathematical Society,' 2nd series, vol. ii. no. 5, pp. 123–136. I quote merely the passages which riveted my attention; and I have ventured to italicize one sentence which seems to me to explain the mystery above mentioned.

"THE employment of the orbit longitude as independent variable throughout all the integrations necessitates a mass of very intricate transformations of terms from one shape into another. Also the integrations which bear on 'elementary terms' must be kept distinct from those which bear on non-elementary terms. A degree of complexity is thus imparted to the subject, which makes it difficult to see when one has really gathered up all the warp and woof of it. *Professor Gyldén has nowhere removed the scaffolding from the front of his building, and allowed us to see what architectural beauty it may possess*; it is necessary to compare a large number of equations, scattered through the volume, before one can opine how the author means to proceed.

"The advantages claimed for the method are that it prevents the time from appearing outside the trigonometrical functions, and that it escapes all criticism on the score of convergence. The first is readily conceded, but many simpler methods possessing this advantage are already elaborated, and it is not so clear that the second ought to be granted. No completely worked out example

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* See 'Observatory,' vol. xii. p. 399.

›f the application of this method has ever yet been published. ľhe great labour involved will naturally deter investigators from employing it."

IN the report of the Sydney Observatory to the R. A. S. Council (M. N. lvi. p. 245) the photographic difference between one night and another is stated in a striking manner as follows :—" Photographic star discs are enlarged by this motion in the atmosphere; frequently they were three times as large in diameter as they ought to be. The light was therefore distributed over nine times the surface and took nine times as long to photograph; so that a star of the 11th magnitude, which on a good night is photographed in one minute, would take nine minutes; and practically it is found that satisfactory photographs of stars cannot be obtained upon nights of such bad definition." The general idea herein contained is not new, and the numerical estimate must not be examined in too exacting a manner; but, as remarked above, there is something striking in the manner of stating this photographic difficulty. There is certainly room for a somewhat extended research on atmospheric tremor from a photographic point of view; and the worst of it is that those who have the heavy work of the Astrographic Chart on hand must perforce resist the temptation to turn aside after enquiries of this kind. It is for them that the results are most important, and it is to them that such questions are most vividly presented; but anything more than a tentative solution must be deferred, on their part at least, until they have broken the back of the task undertaken in 1887. Fortunately, however, there are others ready to take up these interesting questions. We shall, for instance, await anxiously the results of the enquiry sketched by Mr. H. F. Newall incidentally to his most interesting paper read to the R. A. S. at the January meeting. He has been examining photographs of star-trails, and thus studying the detailed movements of the images—not the integrated effect studied by Mr. H. C. Russell in the star disc. Some quantitative results will have an important bearing not only upon photographs, but upon all astronomical observations of precision.

A SENTENCE in the same report, almost immediately following, suggests the question—Is it too late to get rid of the barbarous term *Zone Time*? The word Zone is used in a sense which is not only quite inconsistent with its real meaning, but may very easily lead to serious confusion. The regions adopting the same time are Lunes not Zones: *Lune Time* is the best term that occurs to me, though the suggestion of something to do with the Moon is unfortunate. But even a new word would be better than the word zone, which is always used in connection with latitude, not longitude; and should refer at least to a band going all round the earth —not one extending only halfway. It is too early perhaps to hope for the use of Universal Time, and subdivisions will therefore be with us for some time; but, if it is not too late, it seems worth while to make some effort to obliterate the term Zone Time, which will only discredit us all with posterity when they dig up our literature and find how little we cared about using words properly.

I HAVE just had the pleasure of seeing Mr. Percival Lowell at Oxford. He has been to Algiers in search of a climate, but without success. His personal conviction is that the advantages of increased aperture in a telescope are of the second order of small quantities compared with the advantages of improved climate; and being a man for whom conviction and action are causally connected, he is looking out for the best climate he can get. Notwithstanding he is at present very well satisfied with his position at Flagstaff, Arizona; and his account of the conditions there is certainly enough to fill one with envy. Mr. Lowell very kindly gave me his book on Mars, and to my great surprise I read it right through, every word of it; and I will risk all the horrible suspicions of bribery and cordially advise others to get the book and begin about the second chapter. They will, I feel sure, soon feel the fascination of the story told; and will find it an easy matter to read the book through with attention; and, if I may judge by my own experience, will feel at the conclusion sensibly less sceptical (or shall we say agnostic?) as to the Martian canals and their character. The plot of the story is somewhat as follows (though it is rather cruel to Röntgenize such a living picture of life on Mars):—The general physical conditions on Mars are sufficiently like ours to warrant the supposition that there are living beings there to whom water is important. Now there is precious little water on Mars (*cp.* the absence of cloud), and much of what there is condenses as ice and snow about the poles, melting as the seasons come round. The canals represent the irrigation of the planet by waterways from the poles to conduct the melted ice and snow as quickly as possible over the surface. What we see are not actually canals, but the vegetation bordering them. Irrigation is the great question for Mars. This argument is developed with great skill, and the evidence adduced is drawn largely from observations at Flagstaff during the last opposition. I am not, however, insisting in any way upon the novelty or originality of any of the conclusions, for I am not qualified to speak thereon, either for or against. But it is a very good book to read.

I SAY above begin about the second chapter, because some inaccuracies in the first chapter nearly stopped me altogether; and, with all due allowance for the difficulties of excluding slips of the pen, I think Mr. Lowell should have taken a little more care not to shock people at the outset. The worst case is that of the combination of pieces of evidence, where it is stated at some length that if the chances of a thing being true, in consequence of one piece of evidence, are as 3 to 1, and the chances in consequence of another (independent) piece as 4 to 1, then the total chances in favour of truth are not 7 to 1 but 12 to 1. Here the author is avowedly trying to correct a supposed popular error and makes one himself. I have my own doubts whether in the first instance the ordinary mind would add the chances in the above way—7 to 2 would be more likely; the betting mind would almost certainly adopt Mr. Lowell's process, which is in fact in everyday use by bookmakers for calculating odds on a double event; and naturally to their advantage, for the proper odds are not 12 to 1 but 19 to 1; the chances of failure being only 1 in 20. The wrongness of multiplying 3 to 1 and 4 to 1 to give 12 to 1 can be easily seen by making both the chances even, viz. 1 to 1 and 1 to 1, when multiplication would still give 1 to 1; and no number of independent pieces of evidence, all pointing the same way, would increase the probability of the event beyond that indicated by one of them alone. Now I think an error of this kind in the first chapter of a book very likely to discredit the whole work, and it is a great pity that it was not caught in some way before the sheets were struck off. I must say, however, that it appears to be accidental; for the rest of the book, after the first chapter, shows anything but want of care, though there is another instance of inaccuracy in mathematical statement when the author is treating of the intersections of a number of lines.

THERE is comparatively little need for mathematical considerations in Mr. Lowell's argument, and it may seem ungracious to select them for comment in preference to the really important portions of the argument. But there is a definite reason for so doing, indirectly sanctioned by Mr. Lowell himself. He complains of the confident way in which the possibility of seeing detail on Mars is discussed by those who have never looked at the planet under good climatic conditions: and the justice of this complaint can scarcely be questioned. We who live in a poor climate for observation must be content to receive our information vicariously. But it follows naturally that we have an increased interest in the accuracy of statement of those to whom we must apply for this information; and since we are unable to test statements about Mars directly, Mr. Lowell cannot complain if we look closely at such other statements as fall within our ken. Mr. Marth is always urging those who make astronomical drawings to try and draw the full Moon, not necessarily for publication, but as a guarantee of what they can do in a field familiar to us all.

If Mr. Lowell would have us accept with confidence his observations of Mars, where accuracy is of overwhelming importance, it seems only fair to ask that he should be extremely careful not to shake that confidence by inaccuracy in statements which we can check.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No 240. MAY. 1896.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, April 10, 1896.

Dr. A. A. Common, F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. Turner, M.A., B.Sc., and
E. W. Maunder.

Mr. Maunder read the Minutes of the last Meeting, which were confirmed.

Mr. Maunder. 60 presents have been received since the date of the last Meeting. Amongst those calling for special notice is the book 'Historical and Future Eclipses,' by the Rev. S. J. Johnson, M.A. (a new edition of a very well-known work), and a very interesting and valuable book presented to us by Mr. Maw, containing a number of letters between Sir George Airy, Dr. Hind, and Mr. Bosanquet, on various ancient eclipses.

The President. I am sure you will return your thanks to the donors of these presents. I have not yet had the pleasure of looking through this album, but it seems to be full of interesting letters referring to a great number of eclipses. It relates generally to eclipses of all dates.

A vote of thanks was accorded to the donors of the presents.

Dr. Roberts then read a paper on and showed a photograph of the cluster H VII. 66, and of the nebula H IV. 75 Cephei, which was taken on the 25th Sept., 1895, with the 20-in. reflector, and exposure of the plate during 3 hours. The cluster is described by Sir J. Herschel as considerably large, considerably rich, very compressed, and containing stars of the 11th to 14th magnitude. The photograph was in agreement with the general descriptions given, and in addition showed each star in the cluster in true relative position and magnitude down to about the 17th. The chief use of the photograph will be as a reliable record for future comparison of the stars in the cluster and in the surrounding region of the sky. Sir J. Herschel described the nebula as a remarkable object, considerably faint, pretty large, gradually brighter in the middle, and 3 stars involved. The photograph shows the nebula to be elliptical, measuring 432″ in the direction *n.f.* to *s.p.*, and 285″ in direction *s.f.* to *n.p.* The nebulosity was dense on the *n.f.* side, and involved in it as the nucleus were the three stars referred to by Herschel. Two of them were about the 12th mag., and the third about the 16th mag. There were also eleven other stars ranging between the 12th and 17th mag., apparently involved in the nebula. The character of the nebulosity was flocculent, with extensive dark areas, and there was some structure visible near the *n.f.* margin. There were three stars, each of about the 13th mag., surrounded by faint nebulosity. Another photograph, showing the Owl nebula M. 97 and ♅ V. 46 Ursæ Majoris, was taken with the 20-in. reflector on April 20, 1895, with 4 hours exposure. Dr. Roberts then referred to Sir J. Herschel's and Lord Rosse's descriptions of the nebula. The photograph showed the nebula as an ellipse measuring about 203″ in length. The star in the centre was very conspicuous and of about 15th mag., but there was no other star anywhere in the nebula, although there were two very faint condensations of nebulosity near the *n.p.* margin. The nebula seemed as if it consisted of two nebulous discs superposed, and the photograph did not indicate any nebulous projection beyond the outline of the ellipse.

Sir R. Ball. Will Dr. Roberts kindly tell us the diameter of the Owl nebula?

Dr. Roberts. The major axis is 202″, but I have not given the minor axis.

Rev. S. Kinns. Will you tell us about the three other nebulæ, or are they groups of stars?

Dr. Roberts. ♅ V. 46 Ursæ Majoris is shown on the same plate as the Owl, and was, of course, taken simultaneously and with four hours exposure. Lord Rosse recorded seven observations made of it between 1850 and 1874, and called it a curiously twisted nebula; light mottled. The photograph shows the nebula to somewhat resemble the shape of a *mackerel.* There is one bright and six faint stars involved, besides nebulous condensations and other structural forms.

Dr. Roberts (reading a paper on the relative efficiency of a reflector and of portrait-lenses for the delineation of celestial objects). It has often been asserted that portrait-lenses have, by reason of their short focus, greater photographic power than instruments constructed upon other models, such as the reflector, but the assertion has not been confirmed by my experience in the past. I have therefore thought it desirable to submit the question to some crucial tests, the results of which shall now be given. Two typical portrait-lenses of the best quality obtainable were purchased and affixed to the tube of the 20-in. reflector. The arrangements were such, that three photographs of the objects by the three different instruments could be taken simultaneously under precisely similar conditions. The photo-plates were of the same degree of sensitiveness. The negatives were closely examined, and the stars, including the faintest, were counted. The nebulosity on each plate was also compared.

Of the portrait-lenses used, one was obtained from Messrs. Dallmeyer, of the latest pattern, which covered a photo-field of about 11° diameter. Messrs. Cooke and Sons supplied the other, a Taylor's patent 5-inch triplet lens; a photo-field of 11° in diameter and 95° area was adopted, though a much larger field was good, and my experience of its performances is most satisfactory.

Three typical examples of different subjects shall now be given as illustrations, which will be representative of the whole series.

On a photograph of M 33 Trianguli, taken on Nov. 14th last with the Dallmeyer 3½-inch lens, I counted 380 stars on four square degrees, and assuming the stars to be equally distributed over the field of 95 square degrees, there would be 9,025 stars upon this area. The next photograph was taken with the Cooke lens, and on an area of the same 4 square degrees I counted 840 stars, and there would therefore be 19,950 stars on the 95 degrees. Another picture, taken with the 20-inch reflector simultaneously with the two already described, showed on the 4 square degrees 2,960 stars, which would be equivalent to 70,300 stars on the 95 square degrees. These demonstrate the fact that upon the reflector photograph the nebula was much more extensively depicted, and more details were shown than upon the photograph taken with the portrait-lenses. The stars were 3·52 more numerous on plates taken with the reflector than on those taken with the 5-inch lens, and 7·78 times more numerous than on those with the 3½-inch lens. The examination of the nebulosity and the counting of the stars was in each case done upon the original negatives.

The second series of tests consisted of three photographs of the region of γ Cassiopeiæ taken on 1895, Dec. 9. The first was taken with the 3½-inch lens and upon 4 square degrees. I counted 1,080 stars, which would be equivalent to 25,650 stars on 95 degrees. The photo-diameter of γ measured 18·7 min. of arc. The photograph taken with the 5-inch lens showed 2,610 stars on 4°, which would be equal to 61,980 stars on 95 square degrees. The next photograph was taken with the 20-inch reflector simultaneously with the other two. Upon a photo-field of 4 square degrees I counted 17,100 stars, which would give 406,120 stars on 95°. This would be 15·83 times more numerous than on the photograph taken with the 3½-inch lens, and 6·55 times more numerous than on that with the 5-inch lens. The examination of the nebulosity and the counting of the stars were in both the second and third series of tests made upon the positive copies, and not upon the negatives.

The third series of photographs was taken on Feb. 4, 1896, and exhibited the region of the Pleiades. The first was taken with the

$3\frac{1}{2}$-inch lens, and upon an area of 4 square degrees, with η in the centre, I counted 383 stars, which would be equal to 9,090 stars on 95°. The nebula round Merope was partly shown, but without any structural details, and none of the other well-known nebulosities in the group could be seen. The next photograph was taken with the 5-inch lens, and on 4 square degrees I counted 953 stars, and upon 95° there would be 22,630 stars. The Merope nebula and much of the other nebulosities are well shown and with some details. The last photograph of the series was taken with the 20-inch reflector simultaneously with the others, and upon 4 square degrees I counted 3,470 stars, and upon 95° there would be 82,410 stars. The stars are slightly elongated, but all the well-known nebulosities are densely and brightly shown. The stars are 3·64 times more numerous upon the reflector photograph than upon that taken with the 5-inch lens, and 9·06 times more numerous than upon the photograph taken with the $3\frac{1}{2}$-inch. In all the experiments I have made, the nebulosity shown upon the plates taken with the reflector was denser than on those taken with the portrait-lenses.

The result of these experiments is to prove conclusively the greater efficiency of the reflector form of instrument over the portrait-lens form for certain work in celestial photography. These experiments also point to a practical limit of aperture to focus in the construction of instruments for celestial photography, and that the limit lies very nearly as 1 to 5. The deductions which I have so far made are based upon the performances of lenses of high character. Ordinary portrait-lenses are largely affected with imperfections. Therefore those who engage in stellar photography should first satisfy themselves that their lenses are free from defects, and above all be careful that their plates are efficiently *backed* with some substance to prevent reflection or halation effects.

Mr. Seabroke. I should like to know whether Dr. Roberts has compared the number of stars per unit of superficial area of the plate?

Mr. Inwards. Has Dr. Roberts tried the shorter exposures which are designed for greater rapidity of action?

Dr. Roberts. I have tried exposures of from 5 minutes up to nearly 3 hours with portrait-lenses, simultaneously with the 20-inch reflector, and in all conditions found the reflector to give by far the best results upon both stars and nebulosity. The enumeration of the stars referred to in the experiments was always done on the coincident areas of 4 square degrees on the respective plates, and I endeavoured to be extremely careful in making the experiments and calculations.

Mr. Aldis. Is not the number of stars approximately equal to the squares of the apertures of the three lenses used?

Dr. Roberts. No, not necessarily, as will be seen by calculations made from the data furnished in these experiments.

The President. Dr. Roberts has brought out some very interesting points which perhaps require a little further elucidation. I was very much struck with his remark about the 6-inch. That seems to have upset the whole theory. There is no doubt it is an extremely interesting subject, and will repay further work.

A vote of thanks was accorded to Dr. Roberts for his communications.

The President. As President of the Society I attended the recent opening of the Royal Observatory, Edinburgh, and though I hope Dr. Copeland will be here in the near future to give us a full account of the Observatory, I feel that I ought, without anticipating him too much, to give a short sketch of the chief features of that magnificent institution. You may be aware that the Royal Observatory at Edinburgh consisted of a collection of very antiquated instruments on Calton Hill, which were for many years under the direction of Prof. Piazzi Smyth. When Lord Crawford gave up active participation in Astronomy, he offered his instruments to the Scotch nation. After some time they were accepted and the Government agreed to erect a building to house them. This has been done at a cost of £30,000. The site is on Blackford Hill, from whence there is a clear unobstructed view over 300 degrees; the other 60 degrees is partly occupied by Edinburgh. The main building consists of two domes 100 ft. apart, with a magnificent terrace between. It is built of stone, and the architectural details have been carried out by Mr. Robertson in a luxurious way. Everything an astronomer can possibly want is there—the 15-in. refractor, the 24-in. reflector, which was made by Grubb for Piazzi Smyth; the 15-in. refractor is housed in a dome 40 ft. in diameter, with the floor raised 5 or 6 feet above the level which it is hoped it may occupy when the Government provide a larger telescope. There is a very fine optical room in which spectroscopic work can be carried on, and an underground clock chamber. The observers have houses to live in, and they are about as well equipped as it is possible for astronomers to be. There is a very good description in 'Engineering' of the domes. It is, I think, the only observatory which has been thoroughly established by a Government for many years, and they have done it really handsomely. I think as the Secretary of State for Scotland is a Scotchman this institution will be well looked after; in fact, Lord Balfour of Burleigh said it should have his particular attention.

Prof. Turner (exhibiting and explaining photographs of the Coelostat, which has been made by Messrs. Hammersley for use on the eclipse of August 9th next). As this is a new form of instrument, and its details may not be familiar to everybody, it may be of interest if I give to the Society some notes respecting its adjustments. It will be seen that the apparatus consists mainly of two parts—the mirror with its driving mechanism, and the telescope. The telescope, it will be remembered, remains stationary during the observation in a horizontal position (or nearly so), and at first I thought it would be a good arrangement to have the telescope set up in an observing hut, and the coelostat outside; but experience has led me to see that the exact reverse of this is better, and that the mirror should be under cover and properly adjusted beforehand for the observation, and that the place the telescope should occupy might be indicated by a pair of rails or some such suitable stand. One adjustment, which did not occur to me at first as necessary, is that of the proper distance that the telescope should be from the mirror. If it be too near, the telescope will block out some of the light incident on the mirror; if too far away, the available angular field is diminished. It is not a difficult matter to find by calculation the most suitable relative position.

Another point that has to be attended to is the exact parallelism of the plane of the mirror to the axis of rotation. This can be determined by reversing the mirror in its pivots. Finally, I have been considering the best form of hut in which to mount the mirror, and I have come to the conclusion that a very suitable plan would be to have a square hut with the diagonals east and west, and north and south, then if the coelostat be at the S. corner, and the southern halves of the S.E. and S.W. walls be made as doors to open northward, there will be a sufficient opening, no aperture in the roof being necessary.

The President. This seems likely to be a very important instrument. The advantage it has over an ordinary siderostat is that it will give a picture of a part of the heavens exactly as it is seen in the sky. It is only necessary to adjust the reflector on the part of the sky to be observed and set the machinery going, and then on looking in the fixed telescope one sees continuously the field just as it would be seen in the sky by the naked eye. As to the adjustment that Prof. Turner spoke about of the mirror so that its plane should be parallel to the axis of rotation, it has occurred to me that a convenient means of mechanically adjusting this would be to have the mirror made not with exactly parallel sides, but slightly wedge-shaped, and then putting the lower face on its bearings and rotating it in its own plane the mirror would take up varying inclination, and, when the exact position was found, a mark made on the rim would indicate this effectively. I think that the thanks of those of us who will use an instrument of this kind in the eclipse are due to Prof. Turner for his investigations.

The following papers were announced and partly read:—

Isaac Roberts. "Photograph of the Owl nebula M 97 and of the nebula H V. 46 Ursæ majoris."

Isaac Roberts. "Photograph of the Cluster H VII. 66, and of the Nebula H IV. 75 Cephei."

Isaac Roberts. "On the relative efficiency of a Reflector and of Portrait-lenses for the delineation of Celestial Objects."

Harold Jacoby. "Note on the Solution by Least Squares of the Equations arising in the reduction of photographic star-plates.

Royal Observatory, Greenwich. "Observations of Comet *a* 1896 (Perrine-Lamp)." Communicated by the Astronomer Royal.

A. Marth. "Ephemeris for Physical Observations of Mars, 1896–97."

H. H. Turner. "On the Adjustments of the Coelostat."

The following gentlemen were elected Fellows of the Society:—

William Anderson, Esq., Ballee House, Ballymena, co. Antrim, Ireland; *Thos. Frederick Furber*, Esq., Trigonometrical Survey of N.S. Wales, Department of Lands, Sydney, Australia; *Frank L. Grant*, Esq., M.A., 58 Kelvingrove Street, Glasgow; *Edward A. Reeves*, Esq., 24 Clyde Road, Wallington, Surrey; *George Frederick Herbert Smith*, Esq., B.A., New College, Oxford; *T. M. Teed*, Esq., C.E., F.R.G.S., 188 Camberwell Grove, Denmark Hill, S.E.

The following Candidates were proposed for election as Fellows of the Society:—

Rev. Frederick Lisle Bullen, Littleton Rectory, Thornbury, Gloucestershire (proposed by W. F. Denning).

Ernest W. Ellerbeck, Esq., Borough Meteorologist, &c., The Observatory, Scarborough (proposed by W. E. Plummer).

THE BRITISH ASTRONOMICAL ASSOCIATION.

The fifth ordinary meeting of the present session was held at University College, Gower Street, on Wednesday, March 25, *Mr. E. Walter Maunder*, President, in the Chair.

Fourteen new members were elected, and the names of nine candidates for membership announced and suspended.

Two papers on the Great Red Spot on Jupiter were read by the Secretaries—one by *Mr. C. Roberts,* in which he called attention to the fact that the spot was always considerably behind time in coming to the central meridian, having fallen behind its old position by about 10° of longitude; the other by the *Rev. T. H. Foulkes*, describing a phenomenon which he had often observed, and which, for want of a better term, he described as the "pulsating" of Jupiter's Red Spot. It appeared to the writer as a kind of undulating, throbbing movement, reminding him of the reflection of a dying-out big London fire, as seen thrown upon the clouds at night. While admitting that the phenomenon might be optical or atmospheric, he thought that 25 years' observational experience ought to be a guarantee against such deception. He asked whether any other observers had noticed it.

Capt. Noble remarked that the undulating movement must be on a very big scale to be seen from the Earth.

The President thought that while they had an atmosphere of their own, they need scarcely go to the atmosphere of Jupiter to account for undulations such as had been described.

Several notes and papers were then read under the title of "Eclipse Suggestions."

The Rev. E. Ledger dealt with the question of suitable clothing and simple precautions against mosquitos. He also referred to an old preparation at one time used in collodion photography, called Liverpool emulsion, which he thought might be worth trying if it was still to be got.

Mr. J. Lunt described a sensitometer he had designed and proposed to use at the eclipse for the purpose of estimating the general brightness of the coronal light. It consisted of a long box, one end of which was closed by a photographic plate, the other by a window, the panes of which were graduated from clear glass through various degrees of opacity, the box being divided into two chambers by a partition carrying a lens. A similar exposure could be made on a previous full Moon for comparison, as the President had suggested at the last meeting.

Mr. A. C. D. Crommelin read a paper on "Some of the attendant Phenomena of Total Solar Eclipses." Among the phenomena referred to in the paper were the approach of the lunar shadow in the sky and on the Earth, the shadow-bands, meteorological observations, the effect of the eclipse on plants and animals, the amount of illumination during totality, &c. In conclusion, he warned observers against attempting to do too much, the time—106 seconds—was all too short for any one line of research.

The President offered some suggestions to persons who intended taking cameras to photograph phenomena during the eclipse. Referring to experiences gained during the Solar Eclipse of 1889 Jan. 1, he pointed out the necessity of having the camera mounted quite solidly, more so than was possible with the ordinary tripod-stand; that it would not be well to attempt to make many exposures, and that part of the limited time might profitably be spent in making determinations of the general brightness of the corona and of the surrounding sky.

Mr. A. Fowler read a paper on "A Pocket Eclipse Spectroscope." The plan was devised by Prof. Lockyer a few years ago for another purpose, but seemed well adapted for the observation of a total solar eclipse. It consisted simply of a small direct-vision prism placed between the eye and one of the eye-lenses of an opera- or field-glass. In its most convenient form the eye-lens to which the prism was applied was replaced by a lens of longer focus placed nearer the object-glass, so that the other half of the opera-glass could be simultaneously used for direct observations of the eclipse.

Some lantern-slides were shown to illustrate Mr. Fowler's paper

A dozen photographs taken by Mr. Forgan, showing enlargements, on a scale of 350 diameters, of the grain of various photographic plates, were then thrown on the screen.

The President remarked that he was very much pleased with Mr. Lunt's suggestion for determining the general brightness of the corona, which he thought was a very practical one. He was also very much taken with Mr. Fowler's suggestion for a portable spectroscope. He had made one or two experiments himself on an artificial eclipse, and it was a very pretty spectacle that they had presented to them with this arrangement.

The Secretary read some notes by *Mr. H. MacEwen* on "The Observation of Mercury," intended for those who had had little experience in this department of observational astronomy.

Mr. Hardy exhibited a model of Mare Crisium, a photograph of which was also thrown upon the screen, as was also a photograph of the constellation of Orion by *Mr. Clough*, and four slides illustrating the recent lunar eclipse, by *Newbegin.*

The President announced that several short papers relating to the eclipse of Feb. 28, that there was not time to read, would be published in the Journal.

ROYAL METEOROLOGICAL SOCIETY.

The monthly Meeting of this Society was held on Wednesday evening, April 15th, at the Institution of Civil Engineers, Westminster, *Mr. E. Mawley* (President) in the Chair.

Mr. W. Ellis, F.R.S., read a paper on the "Mean Amount of Cloud on each Day of the Year at the Royal Observatory, Greenwich, on the average of the fifty years, 1841–90," in which he showed that a principal maximum occurs in winter and a minimum in autumn, with a secondary much less pronounced maximum in summer and a secondary minimum in spring. There is, however, considerable irregularity in the succession of daily values, the differences between which on consecutive days are in numerous cases relatively large. Cloudless days are most numerous in spring and autumn, and least so in winter and summer; days of little cloud are somewhat less numerous in winter as compared with other parts of the year, whilst days of medium cloud are much more numerous in summer than in winter. Days of much cloud are nearly equal in amount in all parts of the year; whilst overcast days are much more numerous and nearly equal in amount in the first and fourth quarters of the year, much less numerous in the second quarter, and again less numerous in the third quarter.

Mr. E. D. Fridlander, B.Sc., gave an account of some observations of the amount of dust in the atmosphere made at various places during a voyage round the world in 1894–5. The experiments, which were made with a form of Aitken's pocket Dustcounter, showed that there are often considerable variations in the number of dust particles in a very short space of time. Not only did dust occur in the air of inhabited countries, over the water surfaces immediately adjoining them, and up to an altitude of 6000 or 7000 feet amongst the Alps, but it was also found in the open ocean, and that so far away from any land as to preclude the possibility of artificial pollution, and its existence has been directly demonstrated at a height of more than 13,000 feet.

Major H. E. Rawson gave an analysis of the Greenwich Rainfall records from 1879 to 1890, with special reference to the declination of the Sun and Moon.

*Opening of the Royal Observatory, Edinburgh.**

The new Royal Observatory, which has been erected on the Blackford Hill, Edinburgh, was formally opened yesterday by Lord Balfour of Burleigh, Secretary for Scotland. The ceremony took place in the long optical room, the largest in the Observatory, and was attended by a company which included the Principal and many of the Professors of the University, representatives of scientific societies in Edinburgh and other towns—the Royal Astronomical Society being represented by Dr. Common, Sir Robert Ball, Mr. E. J. Stone, and others—Lord Provost M'Donald, and a few prominent citizens. A large number of ladies were also of the company. On the motion of the Earl of Crawford, Lord Balfour was called upon to preside.

Prof. Copeland, the Astronomer Royal for Scotland, after noting apologies for absence from, among others, the Earl of Rosse, Lord Rosebery, Lord Kelvin, Lord McLaren, the Astronomer Royal, Prof. Lockyer, Prof. Turner, Dr. Downing, and Sir Howard Grubb, at the request of the Chairman read the following historical account of the Observatory:—

My Lords, Ladies, and Gentlemen,—It is very gratifying to the Observatory Committee and myself to see how heartily you have responded to our invitation to meet Lord Balfour, who has so kindly consented to come here to-day to declare this beautiful Observatory open for the study and advancement of astronomy. On looking back at the history of the Edinburgh Observatory, it is interesting to see how from small beginnings it has developed step by step into the truly complete modern observatory in which we are assembled. In 1811 Professors Playfair and Leslie, Dr. David Brewster, and Mr. Jardine, aided by a number of other Edinburgh gentlemen, founded an Astronomical Institution, consisting, firstly, of a "Scientific Observatory, where, with the very best procurable instruments, accurate observations should be instituted for the improvement of astronomy"; and, secondly, of "A Popular Observatory and a Physical Cabinet where members might at any time make observations and experiments in astronomy or any other science, with apparatus which they intended to place there." In aid of this laudable endeavour the Town Council of Edinburgh gave them the use of the old Gothic Tower which still forms part of the dwelling-house on Calton Hill, together with the ground adjoining, on which they eventually built their scientific observatory, from designs by W. H. Playfair. Sir George Mackenzie presented them with several valuable instruments, one of which—a small reflecting telescope—is still in perfect working order. The Calton Hill Observatory as it now stands was very nearly finished when George IV. visited Edinburgh. Gratified by an address presented to him by the members, the King granted permission to call the institution the Royal Observatory of King George IV. In 1834, mainly owing to the exertions of General Sir Thomas Macdougall Brisbane, the Observatory proper was made over to the Crown, and the first Astronomer Royal for Scotland appointed in the person of Thomas Henderson, who was also nominated to the Chair of Practical Astronomy in our University, which had been vacant for some years. Henderson, who had already distinguished himself by his astronomical labours at the Cape of Good Hope, continued to work with unabated zeal in his new post. This was the more possible as the Observatory had been provided four years previously with an admirable mural circle and a large transit instrument out of a Government grant, mainly on the recommendation of Sir T. Macdougall Brisbane. This eminent soldier and patron of science, while governor of New South Wales, for many years maintained an astronomical observatory at Paramatta, and later on a magnetic observatory on his estate at Makerstoun. The results obtained in these institutions form an essential part of the scientific achievements of this century, and it is pleasant to think that his name will be handed down to posterity in that of one of the most flourishing cities of Australia. During the twelve years that Henderson worked at Calton Hill no less than 60,000 observations were made by him and his persevering assistant, the late Mr. Alexander Wallace. Many were the interesting papers written by Henderson on "Cometary Orbits," "The Distance of the Moon from the Earth," and many other subjects, but chief amongst them are his papers on the parallax of the great southern star Alpha, in the constellation of the Centaur. At the end of the thirties, Bessel, the illustrious astronomer of Königsberg, had clearly demonstrated that the double star known as 61 Cygni is separated from the Earth by a distance which it takes light about nine years to traverse, although light, as you know, moves about 186,000 miles per second. Accounts of this grand achievement having reached Henderson, it occurred to him that his own Cape observations of α Centauri might serve as data for solving the same great problem in the case of this star. On subjecting them to the necessary examination, he found that the Earth's annual motion about the Sun produced a perspective displacement of the star with a period of a year, which explained itself by the fact that the star is not much more than 200,000 times as far from us as the Sun, or about two-fifths of the distance of 61 Cygni. Later researches have abundantly confirmed the truth of Henderson's as well as of Bessel's conclusions, and we may say that their labours first clearly demonstrated that the distance of the nearer fixed stars is not immeasurable. Henderson died in the autumn of 1844 at the early age of forty-six, and was succeeded in the following spring by my immediate predecessor, Professor Charles Piazzi Smyth. [Applause.] Shortly afterwards the members of the Astronomical Institution surrendered the remainder of their rights in the Calton Hill Observatory to the Crown. The new Astronomer Royal for Scotland perseveringly gave to the world all that part of the vast store of observations accumulated by his predecessor which had not yet been published. Of Professor Smyth's other work in many fields I can but give you the slightest outline. But this may the more readily suffice, as his own graphic pen and pencil have so clearly illustrated every subject he treated, that he who runs may read. Many of his beautiful drawings and diagrams already adorn our walls, and it will be easy to add to their numbers. His expedition to Teneriffe in 1856, accompanied by the late Mrs. Smyth (whose death occurred only a few days ago), is described in his book entitled 'Teneriffe: an Astronomer's Experiment; or, Specialities of a Residence above the Clouds,' published in 1858. This volume is one of the most fascinating ever written in connection with astronomy. [Applause.] The expedition was undertaken to test the value of a suggestion made by Newton that since telescopes "cannot be so formed as to take away that confusion of rays which arises from tremors of the atmosphere, the only remedy is a most serene and quiet air such as may perhaps be found on the tops of the highest mountains above the grosser clouds." Professor Smyth remained for some months at elevated stations on the great volcano, and through his observations proved beyond all doubt how much astronomy might gain by the establishment of permanent observatories at high altitudes. We may therefore well call Professor Smyth the father of practical mountain astronomy, which at this moment is achieving such great results in several parts of the world. But it is perhaps by his spectroscopic work that my distinguished predecessor is best known. I need only quote 'Madeira Spectroscopic,' 'The Visual Solar Spectrum in 1884,' and his 'Micrometrical Measures of Gaseous Spectra under high dispersion,' to show much he contributed to the advancement of the new science of astrophysics. His studies of the rainband in the spectrum of daylight, in which he was materially assisted by Mrs. Smyth, have placed a new instrument of research in the hands of meteorologists. Many times during his long tenure of office Professor Smyth had drawn attention to "the growing smokiness of the air" around Calton Hill, and eventually a Government Commission in 1876 reported to the Home Office advising that the Observatory should be rebuilt on some better site. The present Earl of Crawford, himself a practical astronomer, strongly supported this plan, but it was not definitely adopted until the year 1889. At this time the Edinburgh Royal Observatory was enriched by the magnificent gift of the astronomical instruments and library which Lord Crawford had collected at Dunecht. These instruments, among which are a refracting telescope of 15-in. aperture, a transit-circle, and a great number of other valuable instruments and apparatus for astronomical and physical work, had already been in use for about fifteen years at Lord Crawford's observatory, where a considerable amount of important scientific results had been achieved. When these instruments were to be transferred to Edinburgh, the necessity arose of providing a building suited for their reception. A committee was appointed by Lord Lothian, then Secretary for Scotland, with Lord Crawford as chairman, the other members being Lord M'Laren, Professor Tait, the Queen's Remembrancer, and myself. We all regret the absence of Lord M'Laren to-day, whose sound advice and unflagging zeal from first to last have contributed in no small degree to the completion of our labours. After a general survey of the neighbourhood of the city, Blackford Hill was selected as offering the most favourable conditions for the new Observatory, and the Edinburgh Town Council, on application, liberally granted the site to the Crown. The Town Council has since taken over the Calton Hill Observatory from the Crown, and is there reviving the old popular observatory by adding to the instruments already there, so that our city—thanks in a great measure to our worthy town's astronomer—will soon possess one of the most complete popular institutions of its kind. Of the building which we are inaugurating to-day, my friend Mr. W. W. Robertson, of H.M. Office of Works, will tell you more in detail from an architectural point of view. You yourselves will be able to form an idea of the scientific capacities of this institution when you see some of our telescopes and apparatus, and when I tell you that it has not yet been possible to place all our instruments in position.

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* From 'The Scotsman,' 1896 April 8.

Mr. W. W. Robertson, the architect, was asked by the Chairman to say a few words about the architectural features of the Observatory. Two things he should like, he said, to mention in connection with the building. One was that nothing in the building or the purpose for which it had been designed had been subordinated to purely architectural considerations. He asked them to think of that, so that they might not regard as defects of architecture points which were entirely due to the scientific requirements of the building. In judging the work of an architect, few people thought it necessary to think of the limitations under which he had worked. Everything in this building of any consequence had been governed entirely by the scientific requirements. For instance, take the two drums on the towers in which the equatorial telescopes were mounted. These were originally designed as domes. Now, he thought the dome was a much more pleasing feature, but the drum was the more useful, and therefore the drum had been adopted. Then the upper portions of the building were governed by the requirement of distance at which these two towers were set the one from the other. The height of the towers was also arranged so that the smaller equatorial on the west tower had a free horizon except at the one point where it was interfered with by the east tower, while the east tower in turn had a free horizon over the top of the smaller tower. The room in which they were in had been governed by scientific requirements. Its distance from the north parapet and its height of roof were so arranged that the rays of the winter sun must reach the siderostat on the platform. The same applied to the smallest details. Even the colours—which he thought perhaps they would not appreciate—on the walls of the observing-chambers had been governed by the requirements of which he had been speaking. There was one point he was particularly anxious to mention, because when he had the privilege of showing a number of his professional brethren over the building he omitted to speak of it. They would find that the top floor of the larger tower cut across a range of windows. They might think that that was a contradiction of what he had been saying. They might think that the outside had been first designed and the inside fitted into it. But he wanted to explain that the floor of this new dome was practically of a temporary character. The dome was designed for even a larger instrument than was in it at present, and when either the Government opened the national purse, or some other benefactor emulated the liberality of Lord Crawford and provided the larger instrument, the floor would assume its proper position. The only other point he wished to refer to was that a certain sum of money had been expended on the decoration of the exterior of the building. He had heard that adversely criticized. But he hoped the building would not be any the worse for scientific purposes because of these decorations. When they considered that the town had dealt liberally with the Observatory in the matter of the site, and that the Observatory was the most prominent feature on the south side of the city, he thought they would agree with him that the expenditure on a building of this kind ought not to be governed by strictly utilitarian considerations. There were certain striking peculiarities, apart altogether from the question of style, which could hardly fail to be noticed when they looked at the exterior of the building. For instance, there was only one chimney on the whole outside. That was to meet the requirements of the Observatory. One unfortunate thing perhaps in connection with the building was that, viewed from the south side of Edinburgh, the mass gave little more than a silhouette. But that was unavoidable, as the position of the towers and the transit-house, which made the mass, was, as he had explained, controlled entirely by the scientific requirements of the building.

Lord Balfour said it now devolved upon him to declare the building open for the teaching of astronomy on University lines. He felt it to be a very great privilege and a great honour to have been summoned there to occupy the chair in presence of so representative an audience. He felt that in coming there to perform this duty he was to some extent entering into the labours of his predecessors. As Professor Copeland had told them, the original conception of the work, whose fulfilment they saw that day, was undertaken at the time Lord Lothian occupied the office of Secretary for Scotland, and almost the whole period of Sir George Trevelyan's tenure had been occupied by the carrying out of the original idea. He now came in at the very end of the work, and he found himself thrown into the place of honour. On such occasions as these they could not avoid looking back, and Professor Copeland had just taken them through a most interesting and instructive history, recalling to them the honourable names which had in past times been connected with the work in which this building was to be engaged. He was right, he thought, in saying that it was just a hundred and ten years since the chair Professor Copeland now so worthily occupied was founded in connection with the University, and that the foundation of the Astronomical Institution, which afterwards became the Royal Observatory, followed but a very few years later. With the Observatory on its old site, the names of Professor Henderson and Professor Piazzi Smyth would always be honourably associated, if for no other reason than the long tenure of office enjoyed by the latter, the high place which he attained among astronomers, and the valuable services which he rendered not only to the University or to Scotland, but to the science of astronomy throughout the world; and, if he might venture to say so, his self-denying services were rendered with at times too slender means and too little encouragement. They must look back to the past with some feelings of reproach, and it would ill become them to forget that there were those difficulties, and that it was in spite of those difficulties his great results were attained. But while they looked back to the past they were also entitled to rejoice in the present, and to prophecy a brilliant future for this institution in honour of which they were met; and if in the past they recollected the names of Professor Henderson and Professor Piazzi Smyth, many generations of their fellow-countrymen would profit by the labours of Professor Copeland and the munificence of Lord Crawford, who was by hereditary right an astronomer. The Earl of Crawford, who held by right of birth one of the oldest Scottish titles, had placed not only Scotland but the United Kingdom under the greatest possible debt of obligation for the public spirit and munificence he had shown. Mainly on account of that munificence, but partly on account of the way in which the Government had acted in the matter, they were now in possession of the largest and best equipped observatory in the kingdom. He understood the site had been carefully selected, and was regarded as satisfactory for all purposes, and that it was as free as possible from the smoke which must always be in the neighbourhood of a large city. Although he had endeavoured to read up a certain number of the past reports of Professor Copeland and his predecessor with the view of endeavouring to gain some slight amount of knowledge as to what were the contents of an observatory, he had only reached that stage of information to teach him the amazing amount of his own ignorance. [Laughter.] He hoped, however, to profit in a small way by the lessons he would get that afternoon. He could assure Professor Copeland that he did not yield even to him in his desire to do anything which could be done by anyone holding his office, to make the institution satisfactory to the University and to the country. There might be other observatories in other countries better endowed and more complete; but, however that might be, this institution was a great advance on what had gone before it, and he looked forward with pleasurable anticipations to a bright future for astronomical study under Professor Copeland in the building. He acknowledged the liberality of the Government in enabling the building to be put up in the way in which it had been, and said that Mr. Robertson had, so far as he was able to judge, done his part of the undertaking in a satisfactory manner. He also acknowledged the frank, and courteous, and liberal way in which they had been met by the municipality in the matter. They were, he said, the ancient patrons of the University, and in their desire to make the building satisfactory for University purposes they had spared neither time, trouble, nor expense so far as they could, and had very generously given the site on which it stood. They had also taken possession of the old observatory on Calton Hill for purposes of popular study, and would carry on the traditions of the old institution at the old place, leaving the new observatory free for scientific study of the important subject committed to the Professor's charge, and for the equally important function of teaching astronomy on scientific lines to University students.

Lord Crawford, in moving a vote of thanks to Lord Balfour, expressed the gratitude of the company that, amid his multifarious duties and in the midst of the holidays, his Lordship had come there that day to formally inaugurate the Observatory. They must have all heard with pleasure the words which he uttered that so long as he was in power it would be his care to do all he could for the Royal Observatory of Scotland. Perhaps they would allow him to say a word or two as to the circumstances which led him to offer such instruments as he possessed to the Government. When some little time ago Her Majesty's Government brought into the House of Lords the Scottish Universities Bill, one of the passages in it upset him very much. It was to this effect, that the Royal Observatory for Scotland was to be done away with stock and lock, that the Regius Professor of Astronomy was no longer to be the Astronomer Royal for Scotland, and that the building upon the Calton Hill was to be done away as a national institution and handed over to the University. His first impression was one of indignation; his second was one of sorrow; and his third impression was that it shan't be. So he went straight to his noble friend, Lord Lothian, and said to him that he really thought it was a very improper proceeding on the part of the Government to do away with what had been a historical landmark in science for so many years, and that, sooner than see it done, he would endow the Royal Observatory with the whole of his apparatus, library, and everything of that sort, so that it would be brought up to the position of a first-class European observatory. After a short period of rest and contemplation, Her Majesty's Government were pleased to accept his offer, and to delete the objectionable passage in the bill, which was passed without it. And that was the history of the present building. They had then to report on a site, and after Dr. Copeland had walked about ten times round Edinburgh and climbed all the hills, the small committee, of which he (Lord Crawford) was chairman, fixed on the Blackford Hill. They had heard of the liberal and hearty manner in which the Town Council had met them, so as to preserve the honour and glory of the old town. A Building Committee was next formed, and that day they were happy to think that the Government was now to take over a building the like of which they might go far and wide to find one so convenient. In fact, Edinburgh possessed an observatory which, though not the largest in the world, had appliances and conveniences for making observations certainly as great as at any other place.

Sir Robert Ball, in seconding the motion, congratulated Professor Copeland in his own name and in the name of the other astronomers present on this auspicious occasion. They were proud of this Observatory for many reasons. They had seen, especially in America, large observatories springing up by the liberality of private individuals, and they were glad now to see that men like Lord Crawford had presented an endowment to the nation which would yield as great and good results as they could expect considering all the conditions of climate. In that matter they were not so well off in Great Britain as in California, where they had the observatory a mile above the level of the sea. Dr. Copeland gave a most interesting *résumé* of the history of his predecessors, but in that spirit of modesty which they knew he possessed he was silent as to his own work in the Observatory. But every astronomer knew and appreciated most heartily the work Dr. Copeland had done. He might only just mention one of his achievements which had come within the last year or two into very great importance. Everybody had heard of the discovery of helium, which had been perhaps one of the most interesting incidents of modern science. This element was discovered in the Sun twenty-five years ago by Lockyer, and the line it gave was not known to belong to any element they knew on earth. Half in joke, it was called "helium." And so that remained for many years, until one day the beautiful discovery was made by Dr. Copeland that this Sun element, helium, was also present in the great nebulæ of Orion, one of the most wonderful objects in the heavens. Then later it was run to earth by Professor Ramsay, who had shown that this element, only known up to that time to exist in the Sun and in the nebulæ of Orion, was also one of the elements they had on the earth. They owed their present knowledge of the wide distribution of helium largely to the discovery of it by Dr. Copeland in the nebulæ of Orion. The ordinary astronomer knew when he got hold of a fact like that—that helium was in the nebulæ of Orion—vouched for by Dr. Copeland, that he was all right; and if any man said that he could not find helium in the nebulæ of Orion, well so much the worse for him. Dr. Copeland had said it was there.

Lord Balfour shortly replied, and the proceedings in the optical room terminated. The visitors then proceeded to an inspection of the building, and were thereafter entertained by Mrs. Copeland to tea in the library.

The Measurement of Double Stars by Interference.[*]

An interesting form of micrometer is described by Herr Karl Schwarzschild in 'Astronomischen Nachrichten,' No. 3335. The idea is gathered from the instrument which Michelson suggested and used for measuring small diameters and distances, an account of which appeared in the 'Memoirs' of the National Academy of Science, Washington, 1891. Michelson, it may be remembered, placed before the object-glass of his refractor a disc in which were two parallel movable slits that set up interference phenomena; and an observation consisted in noting simply the disappearance and reappearance of the interference bands. Schwarzschild's disc, or more accurately oblong framework, on the other hand, contains several slits cut out at equal distances from one another, which cause several images to be visible at the eye-end of the telescope, forming a true multiple-image micrometer.

If one considers the case of the ordinary glass grating as used in spectroscopic work, it is well known that with a bright point as the source of light, we obtain a series of images, the angular distances of which from the unrefracted central image, for a certain wave-length, are given by the formula $\sin a = \lambda n./d$, where λ is the wave-length, d the distance between the lines on the grating, and n their number. In the case of daylight the centre image becomes sharp and white, while the others become broader and broader, in fact small spectra. By exaggerating this idea of the grating, and cutting out of a card slits three millimetres broad and ten millimetres distant from one another, the angular distances of the images for wave-length $\lambda = 570\,\mu\mu$ become very small, and can hardly be separated with the unaided eye. Such a grating as this placed before the object-glass of a telescope directed to a star would show, in the field of view, one colourless image accompanied on its right and left sides by several other images, the first of which would differ only slightly in sharpness and colour from the middle image. It is only to these three images that Schwarzschild pays attention. Of course it is necessary that some means should be at hand by which these images may be moved with respect to one another, and this he accomplishes very simply.

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[*] From 'Nature,' 1896, March 26.

To the object-glass ring, and in a plane parallel to it, he fixes a framework capable of rotation in this plane. Two circular rods, at opposite ends of a diameter of the object-glass, and perpendicular to the framework, are rigidly fixed to the latter, and to these rods is connected the apex of two inclined smaller frameworks containing the slits, the other two extremities of which slide in the grooves of the large frame. Since the distance of this apex from the object-glass can, by means of a rack-and-pinion movement, be increased or decreased, and since also the distances of the different slits vary consequently in a simple known manner, the displacement of the images in the field of view can be easily calculated.

In bringing a double star into the field of view, two parallel series of images would thus be seen, one series from the primary, the other from the companion. The whole framework containing the grating was then rotated in position-angle until the two lines of images coincided; the position of this line was then determined by means of a micrometer eyepiece, and the position-angle read off. To measure the distance between the stars, the rack-and-pinion motion connected with the apex of the two frames containing the grating was then used, until the image of the companion appeared exactly between the two images of the primary. The position of the grating was then read off, and a brief calculation gave the distance required. From a series of observations of several binaries, the total mean gave as a probable error of the mean for each evening :—

Distance.	Probable error in Distance.	Probable error in Position-angle.
2″·3	0″·050	0″·052

The numbers show, as Herr Schwarzschild points out, that greater accuracy can be obtained by this means than by the thread micrometer. He is not, however, very confident about the usefulness of the method, for when the distances to be measured exceed 5″, the colour of the first images becomes very apparent, and thus destroys the accuracy in measuring. Further, the nature of the method stops it from being useful for measuring pairs dimmer than the 7th magnitude, because the aperture of the object-glass is cut down very considerably when the grating is much inclined and the light is distributed over several images. The simplicity of the method has, however, much to recommend itself to many, more especially to those who possess large apertures, and can therefore afford to spare a little light. D.

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*On the Probabilities of Concurrent Evidence.**

THE probability of the truth of a thing due to the fact that two or more witnesses, or other pieces of evidence, agree in the same statement, is found as follows: let t represent the number of times that the first witness tells the truth, e the number of times that he is in error, t' and e' the same with regard to a second witness. Then the probability that the first witness tells the truth is

$$\frac{t}{t+e};$$

that he is in error

$$\frac{e}{t+e}.$$

For the second witness the like probabilities are

$$\frac{t'}{t'+e'} \text{ and } \frac{e'}{t'+e'}.$$

The probability, therefore, that both witnesses agree in stating the truth is

$$\frac{tt''}{(t+e)(t'+e')} \quad \ldots\ldots\ldots \quad (1)$$

and the probability that they agree in error

$$\frac{ee'}{(t+e)(t'+e')} \quad \ldots\ldots\ldots \quad (2)$$

The chance that the first tells the truth while the second is in error is

$$\frac{te'}{(t+e)(t'+e')} \quad \ldots\ldots\ldots \quad (3)$$

and, similarly, the chance that the first is in error while the second tells the truth is

$$\frac{et'}{(t+e)(t'+e')} \quad \ldots\ldots\ldots \quad (4)$$

Now the probability of truth or error resulting from the concurrent testimony of two or more witnesses or pieces of evidence differs from that of the occurrence of a double event, in that, since it is part of the data in the case that the evidences agree, the chance that they should disagree is not a possibility; the only possibilities are that they should concur in truth or in error.

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* See the notes "From an Oxford Note-Book" in the present issue and in that for last month.

Therefore (3) and (4) are each zero. Consequently, te' and et' are each zero, and the chance of both witnesses telling the truth, (1), becomes

$$\frac{tt'}{tt'+ee'},$$

and, similarly, the chance of their being in error, (2), becomes

$$\frac{ee'}{tt'+ee'}.$$

In the same manner, if we introduce a third witness, the resulting probabilities will be found to be

$$\frac{tt't''}{tt't''+ee'e''}$$

in favour of truth, and

$$\frac{ee'e''}{tt't''+ee'e''}$$

in favour of error.

Such is the mathematical calculation of the resulting probability; whether philosophically the probability be calculable is another, more doubtful, matter.

(See Lacroix, Traité Elémentaire du Calcul des Probabilités.)

In order to make the above still clearer, I add a way of looking at it, due to a friend. I will take two concurrent pieces of evidence, the odds that they tell the truth being respectively 3 to 1 and 4 to 1. Then (1), (2), (3), and (4) are in this instance

$$\frac{12}{20};\quad \frac{1}{20};\quad \frac{3}{20};\quad \frac{4}{20}.$$

Now since we know that the evidences are concurrent, (3) and (4) go out, and we are left with (1) and (2), whose ratio is 12 to 1. PERCIVAL LOWELL.

Selenographical Notes.

TOBIAS MAYER.—This ring-plain, at no time a very striking telescopic object, is, however, an interesting example of a considerable formation so closely associated with the mountains which environ it that it seems clear from the character and arrangement of the various groups that it is contemporary with this portion of the Carpathian chain,—thus recalling the evident structural connection of Calippus with the range of the Caucasus and other well-known examples. If observed under a rising Sun when the floor is about half-illuminated, it is evident that its shape, like that of the majority of the so-called "ring-mountains," notably deviates from circularity, resembling a foreshortened hexagon with more or less curved sides, the section on the south-west being almost linear. At this phase also the shadow of the big peak on the west wall, near the place where the deep and bright companion crater *a* adjoins it, is seen to great advantage, obscuring the small crater on the floor and all but one of the bright little hills thereon.

Between 8^h 30^m and 9^h 15^m on March 24, this year, these conditions prevailed, and an excellent view was obtained with a power of 340 of the whole neighbourhood.

The most noteworthy characteristic of the eastern portion of the lunar Carpathians is undoubtedly the great number of isolated mountains of every size which it includes.

These objects vary in dimensions from massive bosses (such as Δ in Neison's map X.) of 17 or 18 miles in length and some thousands of feet in height, to little hills scarcely discernible without great attention, all rising from an apparently smooth and level plain devoid of visible detail. This peculiarity is mostly confined to the region east and south-east of Tobias Mayer, for on the opposite side of this ring-plain the mountains are more closely congregated and form a connected mass of a more normal type, though still differing in character from other ranges bordering the Mare Imbrium on the west and north.

The region surrounding Tobias Mayer is singularly wanting in craterlets: with the exception of *b* on the east, and two small depressions amid the mountains a few miles to the north-west, hardly a crater can be detected. Adjoining *b* on the north-east is a very noteworthy example of an obscure ring about ten miles in diameter with very narrow walls which are discontinuous for some distance on the north. It includes a concentric ridge on the east. This curious formation is prominently shown by Schmidt, but is omitted elsewhere, though it remains easily visible under a high light.

The crater on the floor of Tobias Mayer is a very brilliant little object, becoming more conspicuous as the Sun's altitude increases. It is clearly very deep, retaining shadow when the rest of the interior is nearly free from it, and its inner slopes appear to consist of material of great reflective capacity, rendering the crater easily visible when scarcely a trace of the neighbouring elevations on the floor can be seen.

Schmidt draws three craters within the formation,—one adjoining the brilliant crater just mentioned on the north and of about the same size, and another, still smaller, near the inner foot of the west wall. In addition to these objects, he shows a central mountain, a small circular hill on the northern quarter of the floor, and two other elevations between the central mountain and the bright crater. I am not aware that the existence of the smaller craters has been confirmed, but the other objects are easily seen at a suitable phase.

Though this neighbourhood presents no very remarkable attractions to the observer, it is noteworthy as exhibiting, in my opinion, clear indications of the destructive action of some agency which wrecked and partially obliterated the mountain-barrier which in all probability once divided the Mare Imbrium from the Oceanus Procellarum, and extended from Tobias Mayer to the promontory of Heraclides, thus causing the very notable wide gap in the continuity of the rocky outline of the former "Sea." The relics of this barrier are still easily traceable, being represented by groups of isolated mountains, many of them of considerable dimensions.

These features follow a curved course towards the east and occupy apparently the position where the missing section once stood.

Beaumont House, Shakespeare Road,
Bedford, 1896, April 19.

T. GWYN ELGER.

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*The Coelostat.**

THE principle of this instrument is not new, but has been rarely utilized up to the present time. Attention was recently called to it by M. G. Lippmann (see 'Observatory,' 1895, August), and the advantages of the instrument for eclipse work were so obvious that the Joint Permanent Eclipse Committee of the Royal Society and Royal Astronomical Society immediately determined to construct two instruments on this plan. The Royal Astronomical Society subsequently determined to acquire one of their own, which should be available for Eclipse expeditions; and thus three instruments will be in use at the forthcoming Eclipse, two in Japan and one in Norway. The mechanical details have been designed by Dr. Common, who has also made the 16-inch mirrors; and the actual construction of the instruments has been carried out by Mr. Hammersley.

The photograph which forms a frontispiece to this number represents one of the instruments which has been tried during the last few months at Oxford. The mirror is covered up (the photograph was taken by Mr. Bellamy during a slight shower of rain, being wanted immediately for lecture purposes). The observer is represented using the declination theodolite attached to the instrument for adjustment. The clock-work is behind him, but the clock-weights are shown descending the post which has been erected to give them a long enough drop. In the shed is seen the end of the double tube pointed at the mirror; the photoheliograph lens shows, but the Abney lens, though mounted, is too far within its tube to appear.

As remarked at the last meeting of the R.A.S. (see p. 183) experience has taught us that this arrangement of having the telescope indoors and the coelostat outside is wrong. It is the coelostat which requires permanent shelter (temporary arrangements, such as tarpaulin coverings, are found unsatisfactory), while the telescope can be easily lifted out of doors when necessary, requiring no careful or permanent adjustment.

Hence the arrangements have been recommenced at Oxford *de novo*: a different sort of hut built of posts and Willesden canvas, with the *corners* N.S.E. and W.; and the coelostat inside it at the S. corner. This building is now (April 27) nearly complete, and may form the subject of an illustration in a future number.

The observer shown in the photograph is Mr. John Mullis, the invaluable factotum of the University Observatory, who has carried out all the numerous experiments necessary to settle the details to our satisfaction.

H. H. T.

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* See Frontispiece.

Observer.	Date.	Instrument.	Outer diam. Outer Ring.	Diam. to Encke Division.	Inner diam. Outer Ring.	Cass. Div.	Oute diam. Inne Ring
			″	″	″	″	″
Riccoli & Grimaldi	1650	....	46	...	...	...	...
Huyghens	1657	23-ft. focus Huyghenian. Filar.	39·7	...	...	...	...
Pound	1719	123-ft. focus Huyghenian. Filar.	42	...	...	...	...
Bradley	1719	24-ft. focus, 3·8-in. O.G. Filar.	41·17	...	...	...	...
Rochon	1777	Rochon micrometer.	40·6	...	...	...	...
Zach	1788	Dollond heliometer.	35·04	...	...	...	...
Ussher	1789	....	...	...	...	...	...
Calandrelli	1789	....	...	...	...	...	...
W. Herschel	1789	20-ft. reflector.	...	...	...	...	...
Bugge...............	1789	3½-ft. achromatic.	...	...	...	...	...
Köhler	1790	3½-ft. achromatic.	37·39	...	...	...	...
Von Ende	1791	3½-ft. achromatic.	...	...	...	...	...
W. Herschel	1791	20-ft. reflector.	46·68	...	...	...	...
W. Bessel	1806	7-ft. and 15-ft. reflector.	42·25	...	...	...	...
W. Bessel	1811	16-in. heliometer.	38·27	...	...	...	...
W. Struve	1826	9·6-in. Fraunhofer refr. Filar micr.	40·10	...	35·29	0·41	34·
Herschel & South...	1828	....	40·41	...	...	...	...
W. Struve	1828	9·6-in. Fraunhofer refr. Filar micr.	40·35	...	...	...	...
W. Bessel	1830	Konigsberg heliometer.	39·31	...	...	...	...
„	1831	„ „	39·30	...	...	...	...
„	1832	„ „	...	...	...	...	...
Hussey	1834	Double-image micr.	...	...	...	...	...
Lamont	1835	....	...	...	...	...	...
Encke...............	1837	Filar micr.	40·45	37·47	36·04	0·65	34·
„	1838	Filar micr.	40·93	...	35·69	0·67	34·
Galle	1838	Filar micr.	40·90	...	...	...	34·
Lamont	1838	Filar micr.	40·51	...	...	...	...
De Cuppis...........	1838	Cauchoix refr.	37·44	...	...	...	...
Main	1840	Double image micr.	38·33	...	...	...	...
Challis	1842	Northumberland Equat.	39·95	...	...	...	...
Thompson	1848	....	40·48	3	35·51	0·47	35·
„	1848	....	...	...	...	...	...
Main	1849	....	...	...	...	...	...
O. Struve	1851	(15-in. refr.) Filar micr.	39·74	...	35·14	0·49	54·
De La Rue............	1852	....	...	...	...	...	...
Johnson...............	1852	....	39·43	...	...	...	...
Lassell	1852	....	40·88	...	...	...	...
Main	1853	Double-image micr.	39·60	...	35·78	...	...
Jacob...............	1853	....	39·91	38·09	35·40	0·37	34
Main	1854	Double-image micr.	39·70	...	36·40	...	...
Secchi...............	1854	9-in. refr. Filar micr.	41·00	...	...	...	...
De La Rue............	1854	13-in. Newtonian.	39·83	...	35·33	...	33
Main	1855	9-in. refr. Double-image micr.	...	...	...	...	...
Secchi...............	1855	9-in. refr. Filar micr.	40·90	...	35·06	0·40	34
„	1856	....	40·66	...	34·63	...	...
Jacob...............	1856	....	40·00	37·97	35·82	0·48	34
De La Rue............	1856	....	39·51	...	...	...	...
Kaiser	1856	Double-image micr.	29·72	...	...	...	...
Maedler...............	1860	9-in. Dorpat refr. Filar micr.	40·88	...	...	...	...
„	1861	9-in. Dorpat refr. Filar micr.	40·43	...	...	...	...
Kaiser	1862	Double-image micr.	...	...	...	...	...
„	1863	Double-image micr.	...	...	...	...	...
„	1865	Double-image micr.	39·47	...	35·24	0·50	34·
W. Meyer	1880	10-in. refr. Filar micr.	40·43	...	...	...	...
„	1881	10-in. refr. Filar micr.	40·41	...	34·98	(0·50)	34·
Otto Struve	1882	14-in. refr. Filar micr.	40·16	...	...	...	34·
A. Hall	1886	26-in. refr. Filar micr.	40·45	...	34·95	0·42	34·
Barnard...............	1894	36-in. refr. Filar micr.	40·25	...	34·86	0·56	33·
Dyson...............	1895	28-in. refr. Filar micr.	40·38	...	34·74	0·48	33·
Lewis	1895	28-in. refr. Filar micr.	40·66	...	34·91	0·53	33
Barnard...............	1895	36-in. refr. Filar micr.	40·01	...	35·08	0·47	34·

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* This Table of measures of Saturn's Ring from the time of the earliest observers was referred to in Mr. *Lewis'*
publish it now brought up to date by the addition of Prof. Barnard's recent measures.

Saturn's Rings.*

er a. er g.	Inner diam. Crape Ring.	Space between Crape Ring and planet.	Equat. diam. Sat.	Polar diam. Sat.	Reference.
	"	"	"	"	
	...	...	...	...	Astronomia Reformata, Bononiæ, 1665, pp. 355–9.
18	...	...	(17·75)	...	Systema Saturnium, 1659.
	...	...	18	...	Philosophiæ naturalis Principia, ed. Horsley, Londini, 1779- [1785, vol. iii. p. 7.
10	...	...	17·75	...	Miscellaneous Works of Bradley, Rigaud, p. xcv; Smith's Compleat System of Optics, par. 878.
	...	...	16·9	...	Berlin. Jahrbuch, Sup. ii. 1795, pp. 10, 12.
	...	...	13·10	...	" " 1793, p. 95.
	...	...	18·10	15·85	Trans. Royal Irish Academy, 1789, p. 138.
	...	...	16·1	13·3	Berlin. Ast. Jahrbuch, 1793, p. 96.
	...	...	20·19	18·57	Bessel, Ast. Nach. no. 194, p. 27.
	...	...	11·3	...	Berlin. Ast. Jahrbuch, 1793, p. 96.
	...	...	16·53	...	Königsberger Archiv für Naturwissenschaften, i. 1812, p. 156.
	...	...	17·42	...	Berlin. Ast. Jahrbuch.
	...	...	20·06	...	
	...	...	...	...	Abhandlung, iii. 1876, p. 288.
	...	...	17·46	...	Berlin. Jahrbuch, 1814, p. 174.
7	...	...	17·99	...	Ast. Nach. no. 139, p. 389.
9	...	...	(17·75)	...	Monthly Notices R.A.S. vol. i. p. 74.
	...	...	(17·99)	...	Ast. Nach. no. 139, p. 389.
	...	...	17·01	15·66	Ast. Nach. vol. xii. no. 275.
	...	...	17·06	15·32	" " "
	...	...	17·05	15·19	" " "
	...	...	18·48	16·80	" no. 264, p. 421.
	...	...	16·79	...	
6	...	...	17·52	15·93	Ast. Nach. no. 338, p. 19.
5	...	...	17·68	16·49	" " "
6	22·11	2·11	17·91	...	" no. 756, p. 189; Monthly Notices, vol. xi. p. 185.
	...	...	17·05	...	Jahrbuch der königl. Sternwarte bei Münch. 1839, p. 219.
	...	...	17·00	...	
4	...	...	15·60	...	
	...	...	17·45	15·22	
56	21·86	2·27	17·32	15·46	American Journal of Science, 1882, p. 389.
	...	...	18·76	17·09	Monthly Notices R.A.S. vol. x. p. 7.
	...	...	17·50	...	Greenwich Volume.
95	20·85	1·62	17·61	...	Mem. Academy of Sciences, St. Petersburg, ser. 6, vol. v.
	...	...	17·39	15·96	Monthly Notices R.A.S. vol. xiii. p. 185.
	...	...	16·34	15·48	
	...	...	17·45	...	Mon. Not. R.A.S. vol. xiii. p. 182; Ast. Nach. no. 856, p. 258.
70	...	...	16·40	...	Mem. R.A.S. vols. xviii. & xxv.
32	22·19	2·17	17·86	16·51	Monthly Notices R.A.S. vol. xiii. p. 241.
96	...	...	16·04	...	Mem. R.A.S. vol. xxv.
	...	...	...	...	Mem. Collegio Romano, anno 1852–55.
91	...	...	17·66	...	Monthly Notices R.A.S. vol. xvi. p. 43.
	...	...	16·84	...	Mem. R.A.S. vol. xxv.
71	21·42	1·88	17·66	...	Monthly Notices R.A.S. vol. xvii. p. 52.
	...	...	17·69	...	Ast. Nach. vol. xliv. no. 1060, p. 54.
27	22·21	2·13	17·94	...	" " p. 44.
	...	...	...	...	Monthly Notices R.A.S. vol. xvi. p. 155.
	...	...	...	...	
	...	...	17·25	15·82	Dorpat Volume, xv. ii. 1863, pp. 49–50.
	...	...	17·11	15·90	" " "
	...	...	17·28	15·42	Leyden Observations, vol. iii. 1872, p. 252.
	...	...	17·26	15·24	" " " " "
·86	...	...	16·83	15·47	" " " " "
·30	21·15	1·87	17·40	16·18	Ast. Nach. vol. xcix. p. 167.
·05	21·13	1·68	17·77	16·12	" " p. 167.
·10	20·74	1·49	17·76	...	" no. 2498, p. 17.
·75	20·52	1·40	17·72	...	Appendix ii. Washington Observations, 1885.
·52	20·74	1·50	17·74	16·31	Monthly Notices R.A.S. 1895, May.
·84	...	...	17·77	16·32	" " 1895, Nov.
·92	20·76	1·54	17·69	17·03	" " "
·66	20·53	1·33	17·88	16·14	" " 1896, Jan. (sup.).

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rticle on Saturn's Ring in our number of November 1895. It was not given then owing to want of space. We

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Eclipses and Chronology.

Gentlemen,—

I have been much interested in the remarks of Mr. Lynn in the March number of the 'Observatory,' concerning the eclipse which was mentioned by Plutarch. His suggestion in regard to the eclipse of A.D. 59, April 30, was a good one; and I have since made the necessary computations in regard it. I find that the eclipse of A.D. 59 was central and total at noon in longitude 18° 36′ west of Greenwich, and latitude 29° 45′ north. The nearest approach of the central line of totality to Chaeronea was about 4° 30′ to the southward of that place, at *four o'clock* in the afternoon. The magnitude of the eclipse at Chaeronea would therefore be about the same as that of the eclipse of A.D. 118, Sept. 3, in which the line of totality passed about as far to the northward of that place. But, according to Plutarch's statement, the eclipse occurred at noon, and the time corresponds well with the eclipse of A.D. 118, but differs by *four hours* in the eclipse of A.D. 59. The magnitudes in both cases were about the same as in the eclipse of Pericles, in which some of the stars were visible. Moreover, if the assumed date of the birth of Plutarch is approximately correct, it would seem that the eclipse of A.D. 118 was the more probable one, since the writing of moral disquisitions would hardly be the occupation of a youth of ten or fifteen years of age but would very naturally be indulged in at the mature age of three score years and ten.

Faithfully yours,
John N. Stockwell.

Cleveland, Ohio,
1896, April 13.

Ancient Eclipses.

Gentlemen,—

I have troubled you so frequently on the subject of ancient eclipses that I hesitate at doing so once more. But there are three on which I should be glad, if allowed, to say a few words.

1. I am somewhat surprised that Dr. Ginzel should accept, on the authority of Zech, the view that the total solar eclipse said by Herodotus to have taken place whilst Xerxes was starting from Sardis on his Grecian expedition was that of February 17, B.C. 478. That could not have been an Olympic year, and we all know that an Olympic festival was being celebrated whilst Xerxes was in Greece. Herodotus does not speak of the eclipse as a witness of it: and it may well be that his report of its occurrence from a Persian account confounded the leaving Sardis with the starting from Susa the year before, and that the eclipse was that of April 19, B.C. 481. Prof. Stockwell has indeed contended in letters to you that this, not 480, was the year of the expedition, and that that was an Olympic year. But it is quite certain that

B.C. 478 was not one. What confirms me in the view that the accepted date, B.C. 480, really was that of the expedition, is the fact that Herodotus mentions another solar eclipse, visible in Greece, which frightened Kleombrotus, king of Sparta, whilst fortifying the isthmus, and may readily be identified with the eclipse of October 2, B.C. 480, whilst it seems impossible to account for it if the year was B.C. 478.

2. When I wrote my letter of February 7 ('Observatory' for last March, p. 123) I forgot the eclipse of March 20, A.D. 71. Dr. Ginzel takes this as the eclipse referred to by Plutarch in his Treatise on the Appearance seen in the Orb of the Moon. Surely Prof. Stockwell must have overlooked it. According to Dr. Ginzel, it was very nearly total in Bœotia about an hour before noon, which well corresponds with the time mentioned by Plutarch, Though that philosopher may have been born somewhat earlier than is commonly supposed, he could have been little more than a child in A.D. 59; and whilst it is very doubtful whether he was still living in A.D. 118, at any rate his literary days must have been over before the latter date.

3. A total eclipse of the Sun occurred on Nov. 24, A.D. 29, and its line of centrality passed over the north-western part of Asia Minor. There can be little doubt that this is the eclipse mentioned by Phlegon in a fragment which has been often quoted, and by some supposed to refer, not to an eclipse, but to be the miraculous darkness at the Crucifixion. But, as Lardner points out, there is little reference to this in the Fathers, because it was well understood that an eclipse of the Sun could not take place at the time of the Jewish Passover or of the Full Moon. St. Chrysostom, too, in one of his homilies on St. Matthew, well remarks that the duration of the miraculous darkness proves that it could not have arisen from an eclipse. But Phlegon speaks of a great eclipse of the Sun, mentioning only the year, not the season of the year; and as that of Nov. 24, A.D. 29, was total in the north-western part of Asia Minor, where he lived, we need have no hesitation in accepting that as the eclipse to which he refers. As to the well-known passage in Tertullian, there is no reason whatever, as Lardner points out, to suppose that he quotes from Phlegon at all, or refers to any eclipse. He speaks of a remarkable darkness at the time of the Crucifixion being recorded "in arcanis [or archivis] vestris," meaning probably some public acts or registers sent to Rome from Judæa by the governor, whilst Phlegon's account is of a real eclipse, viz. that of Nov. 24, A.D. 29, probably between four and five months before that time.

Yours faithfully,

Blackheath, 1896, Apr. 8. W. T. LYNN.

On the Errors of Résaux.

GENTLEMEN,—

In the account of the March Meeting of the Royal Astronomical Society, contained in the April number of your magazine, Prof. Turner is reported as summarizing the results of the paper on the errors of the Cape *réseau* which was submitted to the Society by Dr. Gill and myself, as follows:—

"A paper has been received from Dr. Gill and Prof. Jacoby, who have investigated the errors of the *réseau* used at the Cape Observatory. The important result of this is that none of the errors is larger than $0^{\mathrm{mm}}{\cdot}0002$, and that quantity is smaller than the limit of accuracy to which we measure," &c., &c.

The final Table of Corrections in our paper shows that the largest error found to exist in the Cape *réseau*, according to our investigation, is $0^{\mathrm{mm}}{\cdot}0061$, a quantity certainly comparable with the limit of accuracy in measurement. The largest error found by Prof. Donner in the Helsingfors *réseau* is $0^{\mathrm{mm}}{\cdot}0040$ (Acta Societatis Fennicæ, xxi. no. 8). The largest error found by Dr. Gill in the Oxford *réseau* which he investigated is $0^{\mathrm{mm}}{\cdot}0052$ (Memoirs R.A.S. vol. li.).

The largest division error of the principal scale of the Repsold measuring-machine of the Columbia University Observatory is $0^{\mathrm{mm}}{\cdot}0060$, according to an investigation made by the Normal Aichung's Commission at Berlin. The largest division error found by Dr. Gill in the scale of the Cape Repsold measuring-machine is $0^{\mathrm{mm}}{\cdot}0023$. It is not probable that the errors of the *réseau* will be found to be less than those of the best straight scales.

Yours faithfully,
HAROLD JACOBY.

Columbia College Observatory,
New York, 1896, Apr. 13.

[The unfortunate misprint of $0^{\mathrm{mm}}{\cdot}0002$ for $0^{\mathrm{mm}}{\cdot}002$ had been already noted. I am glad that Mr. Jacoby's letter gives the error prominence. But the second sentence in the above extract is altogether faulty. Read "that none of the errors is *much* larger than $0^{\mathrm{mm}}{\cdot}002$, the limit of accuracy to which *we* measure (*i. e.* at Greenwich and Oxford)."—H. H. T.]

Zodiacal Light Observations at the Manora Observatory.

GENTLEMEN,—

Immediately after reading Prof. Turner's interesting communication on the zodiacal light seen at Oxford on March 4, discussed at the last meeting of the R.A.S. (see 'Observatory,' No. 239), I opened our observing journal in order to see whether I had made observations at the same time, and found the following description:—

"*March* 4, 7–$8\frac{1}{4}^{\mathrm{h}}$.—Air 5 (sirocco and vaporous). Barometer 758. Thermometer 12° C. Zodiacal light much more intense than yesterday; at $7\frac{3}{4}^{\mathrm{h}}$ perhaps *eight times brighter* than the Milky Way in Perseus. *Gegenschein distinctly visible* as a round, bright, cloud-like nebula below Leo (Virgo), and about twice the brightness of the Milky Way in Monoceros between Canis Major and Canis

Minor. There are several dark clouds scattered about the sky, which give grotesque forms both to the zodiacal light and to its gegenschein, so that the ordinary cone-shaped form is not to be made out. At $8\frac{1}{4}^{h}$ the clouds covered both phenomena and the whole sky. N.B. The Milky Way was much brighter to-night than the last time."

(The time given above is C.E.T., corresponding to 6–$7\frac{1}{4}^{h}$ G.M.T.)

The brilliancy of the zodiacal light on Mar. 4 makes it probable that it was seen in England too.

Yours faithfully,
LEO BRENNER.

Manora-Sternwarte,
Lussinpiccolo (Istrien).

[Herr Brenner has also favoured us with a series of his observations of the zodiacal light extending from Jan. 15 to April 9, which, although interesting, we are precluded from printing owing to considerations of space. These go to show that the brightness of the zodiacal light depends on certain conditions of the atmosphere, and that during the period March 3 to 6 the light was unusually brilliant.—EDS.]

PUBLICATIONS.

ANNALES DE L'OBSERVATOIRE DE PARIS: MÉMOIRES, VOL. XXI.—The annual volumes published under the direction of M. Tisserand are always examined by us at Greenwich with considerable interest, perhaps because they issue from the institution most like our own, but assuredly because the matters contained in them, generally on a diversity of subjects, always form a valuable and instructive contribution to the science. Volumes of two kinds are published at Paris—one series contains the regular observations made at the Observatory, the other series, under the title of Memoirs, contains investigations by members of the staff. The volume now published is of the latter kind and consists largely of an extension of Lalande's catalogue made by M. Bossert. In Lalande's catalogue the observations made at the École Militaire only up to 1801 were included, but these observations were actually continued to 1804; M. Bossert has unearthed the records of these later observations and from them formed the present supplementary catalogue of 3950 stars, a valuable piece of work. The next memoir, by M. Radau, entitled "Recherches concernant les inégalités planétaires du mouvement de la lune," we hope to speak of at greater length in a later number.

Mdlle. Klumpké contributes an investigation on the subject of Saturn's rings. We believe this covers the same ground as two papers by Mr. F. W. Dyson in the 'Phil. Trans.' for 1893, with which no doubt Mdlle. Klumpké was not acquainted. The methods of the two authors are on different lines, but the results arrived at are practically the same. A chapter of more general interest is that devoted to the Equatorial Coudé, of which a complete description with a diagram is given by M. Puiseux.

M. Bigourdan's observations of double stars are included in the volume, and also his measures of the diameters of Jupiter's satellites. From a long series of measures of these last he finds three sets of diameters made under the following conditions—(*a*) before or during sunset, (*b*) during twilight, (*c*) in a dark field with illuminated wires:—

	a.	*b.*	*c.*
J. I	0″·713	0″·820	0″·893
J. II	0 ·655	0 ·729	0 ·851
J. III........	1 ·250	1 ·342	1 ·551
J. IV	1 ·124	1 ·241	1 ·356

The column (*c*) agrees remarkably with the Lick and Greenwich measures, which were made under similar conditions. M. Bigourdan has also experimented with the double-image micrometer, and apparently arrives at the conclusion that it is unsuitable for measuring diameters. He remarks that Kaiser appears to be the only one who could get consistent results, and this was only attained by excessive labour and a life-long practice. There is little inclination on our part to find fault with these remarks. The necessary time spent in adjusting, the difficulty of noting when the contact actually occurs, and other inherent difficulties make work with this micrometer out of all proportion to the results obtained. One always leaves off measuring with the feeling that the measures are very poor.

STONYHURST. *Rev. W. Sidgreaves, S.J.*—The 1895 volume of Stonyhurst results is to hand. The meteorological and magnetical portion of the work is on the same lines as in many past years (with a few small additions), and calls for no special remark. A new sunshine-recorder, made specially for the Stonyhurst Observatory by Messrs. Newton & Co., has been tested with the Campbell-Stokes recorder and has been found to work satisfactorily. The magnetical absolute-measure instruments have been compared with the adopted standard instruments of the British Association, and appear to be subject to a certain amount of disturbing magnetic influence, due either to the cases or to the metal supports.

The astronomical work has consisted mainly of drawings of the solar spots and faculæ on suitable days, and photographs of the H–K region of the solar spectrum taken with the grating-spectrograph, with the object of observing how closely the double reversals of the integrated solar light follow the disturbances of the solar surface. Experimental spectroscopic work has been carried on extensively with the Father Perry Memorial objective, but the photographic spectra resulting from these experiments are of no value for measurements. A new series of photographs of the spectrum of β Lyræ has been made, the measurements of which were well advanced at the close of the year.

THE ASTRONOMY OF MILTON'S 'PARADISE LOST.'—We have lately received a handsome book[*] of more than three hundred large pages with the above title, and we must confess that our first feeling was one of surprise, to think that a volume so large could have been filled with a subject apparently so limited; on further examination, however, it appeared that the author had not had to resort to "padding" to any great extent. Half the book certainly is filled purely with descriptive astronomy, but all this is very much connected with the subject in hand. The author's purpose seems to have been to show that Milton was an astronomer of no mean acquirements, and so the first eighty pages of the book are devoted to a historical sketch of the science from earliest times up to Milton's day, thus leading up to the chapter showing that the poet was well abreast of the knowledge of his time. Mr. Orchard's idea is that Milton in early life was an adherent of the Ptolemaic system, as is shown by his shorter pieces and minor poems, the line

> "Ring out ye crystal spheres."

being taken as a direct allusion to this theory, that he advanced with the times and adopted the principles of the Copernican system, being influenced perhaps by Galileo and other eminent astronomers, whose acquaintance he made while travelling on the continent. As to 'Paradise Lost,' Mr. Orchard thinks that its topography is based on the Ptolemaic system, but that the poet throughout shows that his views are nevertheless on the other side, as in the passage Canto VIII. 15–38, where Adam is shown explaining to the Angel reasons in support of the Copernican theory. This book, as might be expected, gives many, no doubt all the passages in the poem which contain astronomical allusions, and these are all explained at great length. For example, four lines lead to a chapter of ninety pages on "The Starry Heavens," which is followed by a chapter on the Sun and Moon, because these are mentioned by Milton. But we do not mention these things as adverse criticism; the work is a very good book on general astronomy, and the part about Milton is very interesting reading, and we cannot suggest a title which would describe the book better than that which has been chosen.

NOTES.

COMET NOTES.—A bright comet with a tail was discovered by Swift on April 15. (The telegram gave the date as April 13, but it is clear from the observed place that this was an error.)

The following elements have been deduced by Dr. Schorr from observations on April 16, 19, 20;—

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[*] The Astronomy of Milton's 'Paradise Lost.' By Thomas N. Orchard, M.D. Longmans, Green, & Co., London, 1896. Price 15s.

T = April 17·51 Berlin M.T.

ω	1° 12′	1896·0.
☊	177 55	
i	55 15	
log *q*	9·7515	

These elements do not resemble those of any known comet, but the fact that the axis lies so nearly in the plane of the ecliptic renders periodicity not improbable.

The following ephemeris (for Berlin midnight) has been deduced from these elements:—

	R.A. h m s	N. Dec. ° ′		R.A. h m s	N. Dec. ° ′
May 2....	2 51 4	55 19	May 18....	1 0 52	69 46
6....	2 26 48	60 52	22....	0 31 16	71 10
10....	1 59 36	64 52	26....	0 1 48	72 7
14....	1 30 40	67 44	30....	23 33 6	72 45

It will be seen that the comet is circumpolar throughout the month and observable at any hour of the night. The brightness was greatest about April 22; on May 2 and 26 it is 0·63 and 0·12 respectively of that at discovery.

The comet has been observed several times at Greenwich. It is very bright and plainly visible, in spite of low altitude, twilight, moonlight, and haze.

On April 18 the comet passed very close to the Pleiades.

On April 26 the comet's R.A. was 35 seconds less and its declination 4′ greater than those deduced from the elements given above.

Perrine's First Comet (*c* 1895) was under observation at the Lick Observatory up to March 17. It was seen after sunset on Dec. 20, but was too low to observe.

Prof. Hussey has computed the following elements of Comet *a* 1896 (Perrine-Lamp), which must be very near the truth, as they represent its motion accurately for a period of two months:—

T = 1896 Jan. 31·7751 G.M.T.

ω	358° 21′ 25″	1896·0.
☊........	208 52 26	
i	155 45 37	
log *q*.......	9·76884	

Ephemeris for Greenwich Midnight.

	R.A. h m s	N. Dec. ° ′		R.A. h m s	N. Dec. ° ′
May 2....	4 59 39	39 11	May 14....	5 12 29	38 41
8....	5 6 13	38 54	20....	5 18 29	38 39

The comet was under observation at Greenwich up to April 13, but was then becoming very faint.

Comet *a* 1895 (Swift) was under observation at the Lick Observatory up to February last. Faye's Comet was observed there in October and November, being a very easy object in the 36-inch. Prof. Campbell points out a systematic difference between the R.A. of faint comets as obtained by the method of transits over bright wires and that obtained by the method of distance and position-angle. It amounts in his case to $0^s{\cdot}25$, and he explains it by supposing that the preceding portion of the comet becomes invisible as it approaches the bright wire, so that the centre of gravity is thrown further back. A. C. D. C.

MINOR PLANET NOTES.—Three new planets—CP, CQ, CR—were discovered by Wolf on April 2, 21, 21 respectively. The planets (114) Kassandra and (367) were on the same plate as CP, (367) not having been observed since its first opposition in 1893.

Planets (337), (338), discovered by Charlois 1892 Sept. 22 and Sept. 25, have been named Devosa and Boudrosa respectively.

Dr. Berberich investigates in Ast. Nach. 3343 the orbit of (401) Ottilia, whose period is so nearly half that of Jupiter. He finds the value $584''{\cdot}254$ for its mean daily motion, that of Jupiter being $299''{\cdot}128$. It will be in opposition early in June in S. Dec. 27°. M. Charlois has found a faint trail on a plate taken 1892 Nov. 16 which is probably identical with this planet, being $1\frac{1}{2}^\circ$ from its computed position. A. C. D. C.

ON SOME PECULIARITIES OF PERSONAL EQUATION IN OBSERVING STAR TRANSITS.—A paper by Prof. Newcomb in Ast. Journ. No. 369, deals with a subject which has disturbed compilers of star-catalogues for many years—the variation of personal equation with the magnitude of the star observed. Prof. Newcomb has been making an investigation of this variation, taking as his data the right ascensions of various catalogues, and not the results as given by individual observers, for though he thinks the latter would be the most desirable plan, he finds it to be an almost impossible one. The method of the investigation is as follows:—The differences of R.A. of stars as given by any two catalogues or any two observers are taken to be a function of the magnitude $x+my$, m being the magnitude, and it will easily be seen how a value of y relative to any two catalogues can be deduced. Such values have been found for eleven observers or groups of observers, referring each to the Paris observers from 1860–1880 as standard. Then since the absolute value of y has already been determined for four of these observers, Gill, Küstner, Becker, and Boss, it is possible to deduce from these an absolute value for the Paris observers, which comes out as $+0^s{\cdot}0075$. Using this with the relative values of y above mentioned, there follow these absolute values of y:—

Eye and Ear.		Chronographic.	
Romberg	+0^{s}·0123	Pulkova (1865)	+0^{s}·0124
Pulkova (1845)	+ ·0067	Küstner	+ ·0032
Greenwich (1845–53)	+ ·0074	Greenwich (1854–86)	+ ·0087
Cape (1878–86)	+ ·0118	Boss	+ ·0126
Paris (1860–80)	+ ·0075	Washington (1862–65)	+ ·0048
		„ (1866–68)	+ ·0091
Means	+0 ·0091	Means	+0·0085

which table we take to mean that the Greenwich observers, for example, would record the transit of a 7th magnitude star about 0^{s}·05 later than they would a 1st magnitude star of the same right ascension.

Prof. Newcomb goes on to make some interesting suggestions as to the cause of this variation. Speaking of eye and ear observation, he says: "The observer is biassed in his judgment as to the moment of the image of a star crossing the transit-thread, by his previous estimate of the moment at which it is going to cross, which is based at each moment on the apparent distance between the star and the thread. This distance appears to him greater, the smaller and better defined the image of the star. Hence the bias. It would appear that, in the case of eye and ear observers, this bias ought to be neutralized by a corresponding bias in estimating the position of a star at the clock beat next following the actual transit. That the neutralization does not take effect is probably due to the fact that the observer, being hurried by the necessity of immediately recording his observation, has not the leisure to make the same careful estimate that he has when the star is approaching the thread.

"In chronographic observations there are two methods. In method A, which I believe to be the most common, the observer anticipates the passage of the star, so as to have his signal completed at the exact moment of crossing, much as if he were shooting at a bird. Here we have good reason for the bias. In the other method, B, the observer waits until he actually sees the star on the thread, and then commences the nisus which terminates in the signal."

Of these two methods of observing chronographically, the Professor thinks that the method A is the better (we gather that this is the plan he himself followed when he was an observer); he thinks that method B must necessarily be affected by the variation due to magnitude. It happens that we are able to adduce an example which is not related to the subject of the magnitude of the star observed, but is a striking instance of difference of results from the two methods. Of two Greenwich observers, L. and H., who have observed transits for ten years, it is L.'s practice to "shoot the flying bird," as Professor Newcomb expresses it, while H. deliberately waits until the star is bisected before he attempts to record. The difference of their chronographic personal equations as given in the Greenwich volumes for each year are:—

Year.	L.−H.
1883	$+0^{s}{\cdot}24$
1884	+ ·22
1885	+ ·25
1886	+ ·24
1887	+ ·25
1888	$+0^{s}{\cdot}27$
1889	+ ·26
1890	+ ·27
1891	+ ·24
1892	+ ·21

The sign signifying that H. makes his record on the chronograph late, as might have been expected, *à priori*.

There is another passage which we may be forgiven for quoting: "As the night advanced, there appeared to be no definite moment at which the star was seen as actually bisected by the thread. The subjective phenomenon was that, as the star approached the thread, it suddenly jumped across it as if evading the shot of the key." We note this as an experience which has happened at times to the writer of this; it would be interesting to know if this is common among transit-observers.

Finally, Prof. Newcomb comes to the conclusion that it would be better not to correct star-catalogue places for this variation, although he thinks it a very real source of error, and may have great effect in some investigations.

On the Permanence of the Measures of Stellar Photographs.—It is with a feeling of some concern that those who are engaged in taking astro-photographs often wonder how long the results of their work will last, and whether its value may not be impaired by lapse of time. Dr. Roberts obtained some evidence on this point by counting the stars on stellar photographs soon after they were taken, and then counting them again some years later. He found (see 'Observatory,' vol. xviii. p. 288) that about 34 per cent. of the star-images had disappeared after about 9¼ years. Recently Prof. Harold Jacoby has been making an investigation of a cognate nature to determine whether the *positions* of the star-images change in course of time by any appreciable amount. He had at his disposal several of the Rutherfurd negatives of the Pleiades which had been measured soon after they were taken in 1872 and 1874: these were taken on albumenized plates by the wet process, whereas Dr. Roberts used the gelatine dry plate. On each of four of these plates eight stars were remeasured with the Repsold measuring machine, and the measures converted into polar distance and position-angle to compare with the earlier measures. Prof. Jacoby says, in a reprint from 'Science' with which he has favoured us, that "it is a source of congratulation that the new measures have not brought to light any such alterations of the photographic film as would invalidate measures made on the Rutherfurd plates twenty years after the date of exposure." It is not necessary to give here in detail the results of the comparison; but it may be said that the measures show an average discordance in distance of about $0''{\cdot}1$, and that the maximum discordance is $0''{\cdot}45$. It should be noted that the scale-value has been adopted, so that the sum of these discordances is zero.

OBSERVATIONS OF URANUS AND ITS SATELLITES.—In 'Astronomical Journal,' No. 370, Prof. E. E. Barnard publishes micrometrical observations of the four satellites of Uranus made with the Lick 36-inch refractor in 1894 and 1895. These observations, which Prof. Barnard regrets are not more numerous, but which, however, pretty well cover the orbits, show position-angles and distances of all the four satellites, the distances being measured from the centre of the planet. During the observations, Prof. Barnard was much struck with what appeared to be the elliptical shape of the disc of the planet, and he made a series of settings to determine the position-angle of the major axis of the ellipse, which, though naturally difficult observations, owing to the smallness of the image, tended to show that the equator of the planet, if it be such, does not lie in the plane of the satellite-orbits, but is some 20° or 30° inclined to that plane, a conclusion which has already been arrived at by other observers (Young's 'General Astronomy,' p. 367). Prof. Barnard also attempted some observations of the relative brightness of the satellites, which show that Ariel is about half a magnitude brighter than Umbriel and that Titania and Oberon are about equal in brightness; but these observations brought out pretty conclusively the curious physiological fact that if two satellites of equal brightness are one above the other in the field, the uppermost appears to Prof. Barnard's eye fainter than the lower.

THE obituary announcements of the past month include the name of Mr. Charles Chambers, F.R.S., Director of the Government Magnetic Meteorological Observatory, Colaba, Bombay. Mr. Chambers was born at Leeds, Yorkshire, in 1834. His first appointment was at the Kew Observatory, which he resigned to take up a post in the Persian Gulf section of the Indo-European Telegraph Service. In 1865 he was temporarily appointed Superintendent of the Colaba Observatory, then under the marine department of the Indian Government, and the appointment was made a permanent one in January 1868. In 1886 his official title was altered to Director of the Colaba Observatory, which title he held until his death. Mr. Chambers not only administered the Observatory with much success, but he contributed largely to the sciences of magnetism and meteorology by skilful discussion of observations. Specially he made valuable investigations of the relation between solar and terrestrial phenomena: a paper by him on "The Nature of the Sun's Magnetic Action upon the Earth," in which he came to the conclusion that such action would not be appreciable, is considered valuable, and received the support and approval of Gen. Sabine and Prof. Thomson (now Lord Kelvin). Mr. Chambers was elected a Fellow of the Royal Society in 1869 and received various honours from the Bombay University. His probable successor in the Directorship at Colaba is said to be Prof. Moos, of the Elphinstone College, Bombay.

We hear with much regret of the death of Prof. A. Krueger, Director of the Kiel Observatory, but possibly better known to astronomers as the Editor of the 'Astronomische Nachrichten,' which he has conducted since 1881, and also as the chief of the central bureau for Astronomical telegrams. Prof. Krueger died on April 22, aged 64. We hope to give an appropriate account of his life and work in our next number.

The death is also announced of Dr. William Sharp, F.R.S., of Rugby, who did much during a long life for the popularizing and teaching of science. His activity lay chiefly in the direction of physics and chemistry; but he is connected with astronomy as being a member of the family of Abraham Sharp, the astronomer and instrument maker, contemporary with Flamsteed.

We are indebted to Lord Rosse for the following:—"On March 7th the death occurred in Parsonstown of William Coghlan, who had been for fifty-five years the mechanical assistant attached to Birr Castle Observatory, and had assisted at the casting and polishing of the 6-foot speculum, and the erection of the mounting of the telescope. He was the last survivor of the staff of the workshop, and gave up work only a year before his death. He was by trade a locksmith in a neighbouring village, and showed much aptitude for mechanical work. After coming into Birr Castle workshop he learnt iron and brass founding and moulding, turning, &c.; many such jobs having of necessity to be done on the spot in the midst of an agricultural country."

We have been wondering for some time past why we have not received lately any publications from the Washington Naval Observatory. The matter has been explained by a note in 'Popular Astronomy' for April, which states that the volume for 1890 is set up in type, but that the Government Printing Office is too busy to strike off the copies.

The north wing of the new Observatory at Greenwich is rapidly nearing completion. The dome originally made to cover the Lassell equatorial is now on top of the central tower, where it will cover the 26-inch telescope now being made at the expense of Sir Henry Thompson. Those who are invited to the visitation will also have the opportunity of seeing the new Altazimuth which is now being mounted.

Visitation-Day at Greenwich this year will be on June 6th. The dinner after the Meeting will be at the Criterion Restaurant, Piccadilly Circus, as in recent years.

We understand that Messrs. Scribner have republished M. Trouvelot's astronomical drawings with a descriptive manual. The series consists of 15 large coloured plates, about 36 by 30 inches. There are not many sets now remaining, and the price of these has been reduced to 10 dollars, with cost of carriage extra.

The following curious mistake occurred in a morning newspaper in an account of the opening of the Edinburgh Observatory:—"the telescopes have both driving-clocks, which keep the instruments moving at the approximate speed of the *earth round the sun.*"

We are sorry to hear of the death of Mr. Charles A. Brashear, a leading member of the well-known American optical firm.

Mr. P. H. Cowell, M.A., Fellow of Trinity College, Cambridge, has been appointed Second Chief Assistant at the Royal Observatory, Greenwich.

From an Oxford Note-Book.

On May 11 there is to be another meeting of the Comité Permanent for the Astrographic Chart. It is five years since the last meeting of the Committee, and nine years since the original Conference in 1887, and though the work done in the interval has not perhaps come up to the sanguine expectations formed in 1887 or even in 1891, the progress of stellar photography generally, and of the work of the Chart in particular, has been sure and continuous. There has been a steady advance in the attack on the great work undertaken, which promises well in every way for its ultimate completion; but it has also become more and more evident that the work *is* a very great one, such as will tax the resources of existing astronomical organization to the utmost. It is only the larger observatories that have been able to go ahead with really satisfactory speed; if the smaller ones are to keep pace with them, some additional help must be found for them; and no doubt this will be one of the points considered at the meeting of the Committee. It does not follow that such help need be of a central character, such as might be afforded by the establishment of a central bureau: the subsidies from the several governments which would be necessary to form such a bureau might be quite as economically expended in special grants to their own observatories. But it seems clear that special contributions are needed, unless the work is to drag.

Turning over my scrap-book the other day I came across a curious relic of the original Conference, in the shape of a cutting from *L'Evénement* for 1887 April 22 (exactly nine years ago to-day), headed *La Carte du Ciel,* and signed Georges Duval. It opens with the following anecdote, which I have noted as quite without foundation of any kind, from information received at the time:—

"Hier j'ai été abordé par un monsieur qui m'a demandé avec un accent étranger où était la rue de Rivoli.

"Je la lui indiquai.

"L'ami qui m'accompagnait me dit:

"— Tu ne le connais pas?

"— Non.

"— C'est M. Cristi, de Greenwich.

"— Cristi, de Greenwich? Je ne suis pas beaucoup plus avancé.

"— Le fameux astronome anglais.

"— Comment diable peux-tu supposer que j'ai des relations dans l'astronomie? Sauf Camille Flammarion, qui est doublé d'un poète....

"— Cristi, qui est venu pour le congrès, le fameux congrès où l'on discute la façon de dresser la carte du ciel.

"— La carte du ciel! m'écriai-je alors. M. Cristi va donner son avis sur la carte du ciel et il ne connaît même pas la rue de Rivoli! C'est un comble."

The writer then proceeds to attack the project in a vigorous manner:

"Vous n'avez pas le droit de dresser la carte du ciel, parce que le ciel ne vous appartient pas. Puisqu'il faut une autorisation pour photographier Mlle. Silly, je ne vois pas pourquoi vous auriez la liberté de photographier Uranus, qui n'a jamais joué la comédie. Il y a des personnes qui pourraïent s'en plaindre...... Pauvres que vous êtes, regardez donc à vos pieds avant de songer à vous diriger dans le ciel. Vous n'êtes pas fichus de savoir ce qui se trouve au centre de l'Afrique et vous voulez noter ce qui existe au milieu du soleil."

And he winds up with another anecdote as follows:

"La semaine dernière j'ai surpris un joli tableau. Je traversais la place Vendôme.

"A côté de la colonne un gros télescope reposait sur son trépied. Ses deux yeux, le grand et le petit, étaient ouverts. Son maître était absent. Il attendait la nuit pour montrer la Lune.

"Sous ce télescope, à son ombre, entre les trois pieds, dormait un pâtissier, la tête sur un panier vide.

"Eh bien, dans le ronflement de mon gâte-sauce j'ai vu plus de philosophie que dans votre entreprise. Il l'avait belle pour regarder le ciel. Il préférait rêver à Gothon."

Mr. Percival Lowell has sent a most amiable reply to the criticisms of his book on 'Mars' which appeared in these notes last month. His reply is partly in the form of a personal letter and partly in that of the paper printed on p. 198 of this number. I trust I may quote a sentence from the letter in explanation of the note. He writes from Boston under date April 17. "In regard to the probabilities the statement in the book is unpardonably wrong, but, curiously enough, the odds stated are quite correct, those of your correction not applying to the case in point. This you will see at once, on considering that it is not a question of a double event but of *concurrent* testimony as to one and the same event. To show this I enclose you a short paper," &c. I think a second reference to my note of last month will show that I did not actually bracket the cases of a double event and of concurrent testimony, though I see that the note may be easily read in this way. The objection on which I wished to lay stress was that illustrated by the case of even chances, when "no number of independent pieces of evidence, all pointing the same way, would increase the probability." But there is no reason to enter into a philosophical discussion of probabilities here, if I rightly interpret Mr. Lowell's friendly letter. I am glad to hear that he is already talking of a new edition, for the book is certainly a most suggestive one.

IN these notes for November last, I begged the attention of American astronomers to the proper stamping of letters. The note has brought me several comments of different kinds. Some were in simple confirmation, as in the case of one who writes:—"I have very little correspondence of my own with America, but on three occasions, out of perhaps seven or eight, I have paid extra." Another suggested an explanation, viz. that there is at the present time an epidemic in American gum which prevents the stamps properly adhering, however carefully they may have been stuck. This correspondent suggests that the right stamps may be found in the postbags if search is made; for he has known a case where an erring postbag on the L. & N.W.R. was made to deliver up an American stamp and thus save the excess postage to the recipient of the letter. But quite lately a most painful thing has occurred, which seems to show that we may be as much in fault as our American cousins: for I received a letter from New York enclosing, first a card from an English assistant secretary whose secretarial character is known to be well nigh spotless, acknowledging and expressing sorrow for a mistake in stamping a card addressed to New York; and secondly, an envelope addressed in *my own* handwriting to the same person and insufficiently stamped. Now this is a more awful thing than at first appears: for the transmitter of these damning pieces of evidence remarks in concise American that "the drinks are on you," meaning *me*, and "hopes to see me in Paris in May, as he is coming over to the meeting of the Photographic Committee." I wonder how much drinks cost in Paris? After this I have vowed a vow always to write "Foreign" in big letters on the place where the stamp is to be put, when I address a foreign letter; but I don't know whether I shall save enough that way to pay for those drinks.

IN a recent number of the 'Astronomical Journal' Professor Newcomb has a note on the variation of personal equation with stellar magnitude. He compares different catalogues together, and finds their relative differences in this respect; but to get the absolute systematic error of any one catalogue we must at present appeal to one of four investigations. Without following the details further, it may be remarked that the photographic method affords a ready means of adding to these absolute investigations. Measures on a photographic plate are not affected by personal equation of the kind affecting transits, and can easily be rendered independent of any personality in bisection of images. Thus the variations of a transit personal equation can be easily checked.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 241. JUNE. 1896.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, May 8, 1896.

Dr. A. A. Common, F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. Turner, M.A., B.Sc., and E. W. Maunder.

Mr. Maunder read the Minutes of the last Meeting, which were confirmed.

Mr. Maunder. Seventy-six presents have been received since the date of the last Meeting. Of those which call for special notice I might mention the fourth volume of M. Tisserand's 'Traité de Mécanique Céleste,' which treats of the orbits of the satellites of Jupiter and Saturn and of those of small planets. We have also received three extremely interesting photographs from the Lick Observatory of the Comet Rordame-Quénisset, showing a break-up of the comet's tail very similar to that which was observed to happen to Comet Swift. Mr. W. T. Lynn has presented a little book recently compiled by himself, entitled 'Remarkable Eclipses'; and we have to thank Mr. T. K. Mellor for a new copy of his 'Handy Map of the Moon,' which was first published some years ago.

The President. In asking you to return your thanks to the donors of these presents, I would especially call your attention to these very remarkable pictures of the comet—remarkable for their similarity to Swift's Comet of 1892 and also to Brooks' Comet of 1893.

Prof. Turner. As I have brought the micrometer used at Oxford for measuring the plates of the Astrographic Chart to London, on my way to the Conference at Paris, I thought it might be a good opportunity to exhibit it here this evening. This instrument is similar in principle to the one in use at Greenwich, but the last-mentioned is a duplex micrometer, and requires two persons to use it with advantage. The instrument here is more suitable for an observatory with a small staff. In the focus of the eyepiece there are two small scales at right angles, by which any square of the réseau may be divided into a hundred parts in each direction and by estimation into a thousand parts. The particular square under the eyepiece is defined by two scales on the machine. The measures of portions of the stars on a plate can be written down with great rapidity, about one a minute, by a skilful operator. The micrometer was made by Messrs. Troughton and Simms.

In continuation of some remarks I made last Meeting on the adjustment of the Coelostat, I may add one or two others.

The Coelostat is adjusted in the same way as an equatorial, by reading the declinations of the Sun or of known stars at different hour-angles. The altitude adjustment of the polar axis can, however, be made independently of astronomical observations, if the latitude be known, by means of the level which is fixed to the attached telescope: the process being to set the telescope to read a south declination equal to the colatitude, and raise one end of the polar axis until the level indicates a horizontal position. A single observation of a known object will then give the only remaining adjustment, in azimuth; but the observation should of course not be too near the meridian. An actual meridian observation might be used however, but as a transit and not as a declination reading, if another level be provided for levelling the declination axis of the telescope. If the Sun is so high that any portion of the roof obstructs the view, a reflection observation may be used under certain conditions. Finally, a graphical method can be used in determining the errors of adjustment of the polar axis. If the errors in declination at different hour-angles due to a given mal-adjustment of the instrumental pole are plotted down on paper as radii vectores drawn from a point in directions corresponding to the hour-angles, their extremities will lie on a circle passing through the point. If any two radii vectores are known from observation, the circle drawn through their three extremities gives a complete determination of the problem, and the errors at 0^h and at 6^h (corresponding to the components of error in altitude and azimuth) can be easily read off.

Prof. Turner then exhibited some slides showing the final mounting of the Coelostat in its hut of wood and Willesden canvas, showing on the same slide all the parts of the instrument, the covering, the observer, and even the image of the object observed; this last being an image (or rather two images) of the Sun on the ground-glass of the photographic telescope, which was pointing downwards at the mirror of the Coelostat.

Mr. Dyson. I am sure we are all glad that Prof. Turner has taken this opportunity to show us his measuring apparatus. It is pretty well accepted, I believe, that astronomers are very apt in their mechanical appliances; but nothing could be simpler than this machine. Prof. Turner did not tell us that he has already measured 120 photographs for the Astrographic Catalogue, and that these show on the average about 250 stars each, from which it may be seen how rapidly work can be turned out with this machine. I wish also to express my thanks for the illustrations and descriptions we have had of the coelostat. This is a subject in which we are all interested, as showing the methods that will be employed in the forthcoming eclipse.

The President. With Mr. Dyson I have had the pleasure during the past few days of seeing the arrangements Prof. Turner has made at Oxford, and I have formed a strong opinion from what I have seen that as an instrument for eclipse observation the coelostat is almost perfection. But to get perfection it is necessary to study a thing such as this thoroughly to get its capabilities fully developed, and this Prof. Turner has done. I think that not only is this instrument an excellent one for observation of eclipses, but also that it might be used with advantage in an observatory. I will ask you to return your best thanks to Prof. Turner for his pictures and description.

Mr. F. McClean then read a paper on and exhibited photographs of spectra of the helium class of stars. The photographs had been taken during the last twelve months in the course of his regular work of photographing the spectra of the northern stars down to the third magnitude. When the series was begun helium was not then in question, but soon after the discovery the spectrum of the new element was further identified with the characteristic spectra of a certain class of stars. The whole series of spectra which he had taken included 160 stars.

Mr. Maunder said that he had brought a few slides illustrating the very rhythmical character of the spectrum of helium as it had been observed by Profs. Runge and Paschen. When Dr. Huggins photographed the ultra-violet spectrum of the white stars like Sirius it became clear that the great dark lines which the photographs revealed were obviously part of the same rhythmical series as the known lines of hydrogen. Later on Prof. Ames succeeded in obtaining these lines of hydrogen in the laboratory, whilst in 1886 Mr. Balmer had enunciated a formula connecting the entire series of hydrogen lines by a very simple arithmetical relation. (A slide then exhibited on the screen showed that the formula for the oscillation frequency of the hydrogen lines was the equation to a parabola.) Professors Kayser and Runge succeeded in establishing a general formula for the spectra of metals, of which Balmer's formula was only a special case, and showed that in general an element gave three rhythmical series of lines, a principal series of wide intervals, and two subordinate series, both of which approached the same limit. (Slides illustrating the analysis of the spectra of lithium and sodium were then thrown on the screen.) The spectrum of helium, or rather of the gas from clèveite, gave six series which arranged themselves naturally in two sets, each set containing one principal series and two subordinate series. These six series accounted for every line in the complicated spectrum of the gas, and the inference was very strong that the clèveite gas was really a mixture of two gases, of which analogy would point out the gas giving the D_3 line to be the heavier. But before Profs. Runge and Paschen had begun their researches, directly Prof. Ramsay had revealed the new gas to astronomers, Prof. Lockyer and M. Deslandres had at once declared that the gas must be a mixture, not a simple gas, for some of the lines of its spectrum behaved in one way in the solar chromosphere and others in another. D_3 and Lorenzoni's *f*, for example, were always seen in the chromosphere; other of the clèveite lines only occasionally. And the division which Prof. Lockyer and M. Deslandres made on the ground of their solar observations, corresponded exactly with that made by Profs. Runge and Paschen on the entirely different ground of the rhythmical relationships of the lines. There was, therefore, much reason to think that in the gas from clèveite they had made known to them not one element only but two. The one was helium, the element giving rise to the D_3 line; for the other Dr. Johnstone Stoney had suggested the name "parhelium."

Mr. Shackleton exhibited some photographs of the spectra of "helium" stars.

The President (referring to the picture shown on the screen). The spectrum shown here has the red end to the right, whereas the diagram shown by Mr. Maunder had the red end at the left. Is there not some convention as to this point?

Mr. Fowler. The editors of the 'Astro-Physical Journal' lately sent out a circular in which they took the opinions of different persons, and it was decided by the majority that the red end should be always represented to the right, and certainly in practice this works very well. The name of helium stars may be certainly a very convenient one, and probably as good as any other for the class of stars described by Mr. McClean, but we ought to be very careful not to let it mislead us. Although helium and hydrogen are almost the only things which give us any indication of their presence, there is reason to suppose that such substances as iron and manganese, which we have not seen, may be present in these stars. If the Sun had been at a stellar distance we should never have known anything about the existence of helium in the Sun; but our knowledge of its presence entitles us to suppose that helium is also present in the atmospheres of stars like Arcturus, which at first sight appear to have no connection with the helium stars.

Prof. Turner. I remember several years ago, in fact when I went on the Eclipse expedition of 1886 with Profᶠ. Lockyer, that he impressed on me that the red end should always be to the right, pointing out as a *memoria technica* that both words began with "r."

Prof. A. S. Herschel made some remarks on an analogy between

Balmer's law referred to by Mr. Maunder and a certain problem in acoustics.*

Mr. Maunder. Fellows may like to be reminded that Prof. Herschel was the first to point out the rhythmical character of a spectrum in the case of the lines of the great green band of carbonic oxide long before the formulation of Balmer's law.

A vote of thanks was passed to Mr. McClean and to the other speakers who had contributed to the discussion.

The President then called on Prof. John Milne, F.R.S., of the Seismological Society of Japan, to address the Meeting.

Prof. Milne. When I was in Japan, occasionally I ventured to address audiences on the solar system, spectrum analysis, and other branches of astronomy, but here I hardly feel myself competent to speak on any subject other than that which relates to the movements of the Earth's crust, on which I with others have made many observations in Japan and elsewhere. First I would speak of the large movements which are of interest to the geologist, those great but gradual upheavals of long duration which it seems possible may have been detected by astronomers who have noted the secular changes in the direction of their zenith. At many observatories annual changes in the vertical of from 2″ to 14″ are noted. At certain Swiss observatories, where organic action may not yet have ceased, changes of 5 or 6 times this amount have been recorded, whilst in Japan it was observed that the greatest movements were in a direction parallel to the dip of the rocks. That is to say, in two countries where there is every reason to believe that bradyseismical action is not yet ended levels indicate that motion is taking place rapidly, and is most marked in the direction we should expect to find it marked.

Next I refer to the subject of earthquakes, which are of more frequent occurrence than is generally supposed. In the Isle of Wight there may be in one week twenty or thirty small earthquakes which entirely escape notice. A remarkable thing about large earthquakes is that such phenomena may happen in one part of the world and be recorded in any other part of the world, the tremors and waves travelling with an enormous velocity, a velocity greater than that with which a vibration would travel through glass or steel. The question therefore arises "what is the medium through which these tremors are conveyed?" It is almost certain that the medium is not the rock which forms the Earth's crust, and this seems to point to the conclusion that the tremor passes *through* the interior of the Earth, which leads to the enquiry as to the material which forms this interior. To investigate this question it would be necessary to have observing stations round the world to pick up, as it were, the tremors on their journey. Besides these earth-movements, which are the result of a crumpling crust, there are diurnal movements. The building we are now in is probably moving in some direction or another; observations show that some buildings tilt slightly during the day, and move in the opposite direction at night, but do not settle back to exactly the same place. This tilting varies in amount, on different days and at different places, and it is a remarkable fact that it is seldom observed of great extent on a very cloudy day or a very rainy day, so that we may conclude that it is due to some cause connected with solar radiation. Turning now to tremors, it may be remembered that when an eclipse expedition went to Japan on a previous occasion it was never possible to get a good photograph, owing to the unsteadiness of the instruments. At certain times tremometers often behave apparently most inconsistently. In a building which seems solid and perfectly suitable for delicate experiments, these instruments show various and irregular vibrations, whereas sometimes under circumstances when it would seem that they must be affected by air-currents, they remain perfectly still. It is remarkable that in Great Britain there is not one observatory for observing movements of the Earth's crust. The Earth is popularly called *terra firma*, but in my opinion the description is quite inappropriate; it is continually breathing and palpitating, and yet we are doing little or nothing to investigate these movements, which directly or indirectly affect not only the Astronomer but all who live upon its surface.

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* Prof. Herschel's speech is reprinted as an article on page 232.

Rev. W. Sidgreaves. I should like to ask Prof. Milne whether he has found it necessary to take precautions to protect the pendulum from disturbance by movements of the air. Both at Kew and at Stonyhurst suspended magnets have been found oscillating for a considerable time under their *air-tight* covers. These oscillations are very rapid, and have been attributed to a circulation of the air within the covers, set up by a cold current striking them from the outside when the doors of the room in which they are placed have been left open, accidentally or otherwise.

Mr. Stone did not think that real changes of the vertical of such amount as Prof. Milne mentioned had been observed at any English observatory. He asked whether it was possible to distinguish easily between real earth-tremors and those caused by trains and other traffic.

Prof. Milne. In reply to the suggestions put forward, I will at once say that there is always the possibility of a light horizontal pendulum being disturbed by air-currents; and in certain instances it has been difficult to distinguish between movements caused by such currents and those due to real earth-tremors. Recording magnets of magnetic observatories have often recorded small local earthquakes and movements due to earthquakes, the origin of which may have been distant a quarter of the Earth's circumference. As to the disturbance caused by trains and traffic, I can say that I can work quite well in the vicinity of a railroad with a delicate apparatus, which will easily show deviations of $0''\cdot 1$, and get good results. The subject of geodynamics is a very large one, and there are many volumes and papers published on each of the points raised to-night. In Japan there are 968 stations for the observations of earthquakes alone, and the documents collected from these amount to hundreds of thousands.

The followings papers were announced and partly read: —

R. H. M. Bosanquet. "Note on a Determination of Precession and Drift, based on Auwers' Proper Motions."

Royal Observatory, Greenwich. "Diameters of Jupiter measured with the Filar and Double Image Micrometers." Communicated by the Astronomer Royal.

F. McClean. "Photographs of the Spectra of 23 Characteristic Helium Stars; also Photographs of the Spectra of 6 Stars of the 3rd Magnitude, showing the Transitions from Type to Type."

Royal Observatory, Greenwich. "Observations of Comets *a* 1896 (Perrine-Lamp) and *b* 1896 (Swift)." Communicated by the Astronomer Royal.

T. J. J. See. "Researches on the Orbit of 42 Comæ Berenicis."

A. Marth. "Ephemeris of the Satellites of Mars, 1896–97."

R. H. M. Bosanquet. "Second Note on a Determination of Precession."

E. J. Stone. "Tables for Facilitating the Computation of the Changes in the Star Corrections between the nearest 'Mean Midnight' for which the Logarithms of the Day Numbers are available and the Time of Observation."

The following gentlemen were elected Fellows of the Society:—

William Banks, 30 Corporation Street, Bolton; *Alfred Ernest Young*, Assoc. M.Inst.C.E., Trigonometrical Survey of Perak, Taiping Perak, Straits Settlements.

The following Candidates were proposed for election as Fellows of the Society:—

Lewis Evans, J.P., F.S.A., Barnes Lodge, King's Langley, Herts (proposed by Sidney Waters).

John Anderton Greenwood, LL.M., B.A., Brooklyn, Earl's Court Square, S.W. (proposed by Capt. D. Forbes).

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE sixth ordinary Meeting of the current session of the Association was held at University College, on Wednesday, April 29, *Mr. E. Walter Maunder*, President, in the Chair.

Eight new members were elected and the names of nine candidates for election were read and suspended.

Dr. Gill, H.M. Astronomer at the Cape, gave a short address on the work of the Cape Observatory. He referred in the first place to the work done in connection with the International Astrographic Chart, and stated that all the catalogue-plates which contained the stars to the 11th order of magnitude for the zone undertaken by the Cape Observatory were finished and he was awaiting definitive instructions from the International Committee before proceeding with the chart-plates. Another important piece of work had been the completion of the reduction of the observations of Victoria, Sappho, and Iris. The results of the observations of these minor planets gave a value of the solar parallax which agreed almost precisely with that arrived at by Prof. Newcomb from a complete discussion of the parallax by direct trigonometrical methods; but when the mass of the Moon was determined from these observations there was a remarkable discordance between the results, and he was prepared to defend, at the approaching meeting of the Superintendents of the four Nautical Almanacs, the value derived from the observations of the minor planets, particularly as compared with that which was derived from transits of the Sun. Another important matter which has been brought to a successful conclusion is the photographic chart of the heavens from declination 18° S. to the S. pole, which includes approximately all stars to the 10th magnitude. The result was that they had a catalogue of about 450,000 stars, which would be published in three volumes of about 800 pages each. The first volume was printed, the second was in the press, and the third would be ready before the printing of the second was finished. In conclusion, Dr. Gill referred to the completion of the geodetic survey of South Africa, begun in 1882 and finished in 1893, and the final published results of which he had brought home with him.

Dr. Downing and the President heartily congratulated Dr. Gill on the successful completion of so much of the programme he had set himself.

Mr. Schooling read a note by the *Rev. F. J. Eld*, on "A Remarkable Facula." The observation was made on April 13, when the spot was close upon the limb of the Sun. The faculæ appeared piled up into a peaked mountain of prodigious height, and reminded the writer of a snow-clad Alp seen from a distance.

The President said that the facula to which Mr. Eld alluded was recorded on the Greenwich photographs and certainly looked exactly like a white mountain projected on the black background of the spot.

A paper by *Mr. C. Roberts*, on "The Present Appearance of Saturn," was then read. The paper was illustrated by a drawing made April 25, 12^h 30^m. The belts on the ball were very well seen, the broad N. equatorial belt being clearly double, and several dark patches on it gave it a mottled appearance. The narrow equatorial band was traced almost from limb to limb. North of the N. equatorial belt was a rather narrow, fairly bright zone; then another pretty broad belt, and north of this a dull zone, and then the dark N. polar region.

Mr. Green remarked that M. Antoniadi at Juvisy had recently had, on April 18, the good fortune to detect a new and well-defined division and two fainter ones on the inner bright ring of Saturn. The first division could be easily seen in a 6½-in. reflector. The other two divisions could only just be glimpsed with the 9¾-in. equatorial at Juvisy, magnifying some 300 diameters. Instead of the Encke division, ring A showed some enormous white spots separated by dusky intervals. The ring appeared broken as it were into fragments.

The President remarked that the curious markings indicated in M. Antoniadi's drawing resembled very much the markings shown in a celebrated drawing of Saturn by M. Trouvelot made many years ago and since frequently engraved. As there was a week's interval between M. Antoniadi's and Mr. Roberts's drawings there was no necessary contradiction between them.

A chart of Jupiter, by *Mr. H. F. Griffiths*, made from a set of drawings of the 16th, 19th, and 22nd March, was thrown on the screen.

Mr. Maw and the President both congratulated Mr. Griffiths on the beauty of the drawing and the skill and attention displayed. Following this a table prepared by *Mr. Crommelin*, showing the elements and ephemeris of Swift's Comet, was thrown upon the screen. Mr. Crommelin stated that the comet was now coming into a better region for observation and that it ought to be visible with ordinary instruments for at least a month more. Some slides of star-fields by *Mr. Clough*, of Southport, were also shown, taken with a Dallmeyer portrait-lens of 3½-in. aperture and 10¼-in. focus attached to a 9¼-in. "With" reflector.

Mr. Mallett discussed the best method of hand-drawing the approaching eclipse. He strongly advocated drawing with white or tinted crayons on dark-tinted paper, and suggested 4½ centimetres radius as a suitable scale for the Moon.

Dr. Isaac Roberts read a paper on "The Relative Efficiency of a Reflector and of Portrait-Lenses in Celestial Photography."

Dr. Gill thought that Dr. Roberts had rather exaggerated the advantages of the reflector with which he had done so much admirable work. It was not fair to compare a 3½-in. or 5-in. lens with a 20-in. reflector. A fairer comparison would be between a 5-in. lens and a 5-in. reflector. He believed that the new Taylor lens was the best astronomical lens for a large field which had yet been brought out.

ROYAL METEOROLOGICAL SOCIETY.

The monthly Meeting of this Society was held on Wednesday evening, May 20th, at the Institution of Civil Engineers, Great George Street, Westminster; *Mr. E. Mawley, F.R.H.S.*, President, in the Chair.

Mr. R. H. Curtis read a paper on the exposure of Anemometers, in which he gave the results of a comparison of the records from the three anemometers at Holyhead, viz. the Robinson, the bridled, and the pressure-tube anemometers. It was clearly shown that the force of the wind is greatly affected by surrounding objects. The author is of opinion that for anemometrical records to be reliable and of value not only must the instrument be exposed in an open place, free from local obstructions, but it is also absolutely essential that the stand which carries it shall offer practically no resistance to the wind, and that the instrument should not be placed on the roof of a house. The paper was illustrated by a number of lantern-slides.

An interesting collection of photographs of clouds sent to the Society by Mr. H. C. Russell, F.R.S., of the Sydney Observatory, was also exhibited.

On the curious Light seen at Oxford and other Places, 1896 *March* 4.

I WAS much interested in reading, in the 'Monthly Notices of the Royal Astronomical Society' for March and April, in the 'Observatory' for April and May, and in the 'Journal of the British Astronomical Association' for April, the various accounts and notices of the "curious light" seen by different observers on the evening of March 4 last. I did not myself see the light in question, but having in the course of a long experience seen numerous manifestations of the aurora, I am tolerably well acquainted with the many different forms under which it appears. I have also seen various large comets, and am familiar with the appearance of the zodiacal light in this latitude. I would therefore, if I may so presume, offer some remarks as to the probable nature of the appearance of March 4.

Some of the observers concluded that the light was auroral, others were divided in opinion as between the zodiacal light and the aurora, whilst some compared it to the tail of a comet, without in general being able, as it were, to assign the appearance to a distinct cause; but to one of the three mentioned it would undoubtedly seem to belong. The question as to which seems to me to be to some extent one of relative probability, having regard (1) to the comparative frequency of either phenomenon, and (2) to a consideration of whether the facts observed are on the whole better in accord with the known appearances presented by any particular one of the three phenomena.

Without presuming to superior powers of observation, I may remark that I could usually readily distinguish between the zodiacal light and the aurora. There seems to be between the two phenomena a difference not only in general appearance but also in behaviour, if there be opportunity of watching the particular phenomenon even for a comparatively short time. Of course some experience will enable a person more readily to form a judgment, since he will better know the various appearances that different phenomena present.

The instances in which a large comet has suddenly come into view are rare, besides which, so far as I am aware, nothing is known of any comet that could have produced the appearance seen. Considering also that the evidence for the light being cometary consists of impressions only, the question of its having been the tail of a comet may probably be altogether laid aside. On the other hand, the zodiacal light and the aurora are much more frequently seen, and may by comparison be said to meet on much more equal terms.

The report from the Radcliffe Observatory, Oxford, is that the zodiacal light was seen on March 4 between 7^h and 8^h P.M., and that "it was very distinct and bright, extending in the usual lenticular form nearly to the *Pleiades*." Leo Brenner gives confirmatory evidence from abroad as to the zodiacal light being bright at this time. In neither account is there mention of any abnormal beam or band of light. And those who did see the beam do not appear to be really satisfied that it was connected with the zodiacal light, but rather the contrary. Thus Mr. Bellamy, at the University Observatory, Oxford, "had often observed the zodiacal light in Oxford, but this appearance struck him as quite unfamiliar." Professor Turner himself says, "besides the extraordinary brilliancy of the light, the concentration of it along the axis of the cone (assuming it to be really the zodiacal light) was remarkable, suggesting at first nothing so much as the tail of a comet as bright as that of 1882"; but further adds that "the edges were comparatively well defined, and did not present the gradual fading off usually seen in the zodiacal light"; whilst Sir W. J. Herschel, who appears to have seen the zodiacal light in the early part of the evening, says of the later apparition that "the whole thing was a striking, sharply defined object, and therefore quite alien, to my knowledge, to the idea of the zodiacal light." He further describes the light as "parallel-sided . . . . with very well-defined edges." Mr. Cope, at Malvern, speaks of the appearance as "resembling an electric search light," which he considered to be auroral, and he further describes it as varying considerably in length during the time that he saw it. Again, Professor Turner describes the light as having soon "become much fainter, though still brighter than Mr. Bellamy remembered to have ever seen the zodiacal light." He adds, "It was fading rapidly, and within a few minutes was no longer very noticeable," which, he remarks, seems "quite inconsistent with the idea of the light disappearing by *setting* rather than by *fading*." He considered that "there was no motion apparent." But Mr. Newall's assistant at Cambridge reports the "ray" as "evidently shifting southwards," and Mr. Cope thought that it shifted "to the left," that is southwards. Mr. Bellamy estimated the width of the beam "at barely 1°," which Professor Turner confirms. Mr. Martin, at Dunsink, saw "the light" for about two minutes, when thick clouds hid it; he estimated it as "5° wide." Mr. Monckton, at Wolverhampton, says "the width of the light kept nearly the same till it tapered off a little, high up in the sky."

Now it appears that the zodiacal light was undoubtedly seen on March 4, and it is evident that later in the evening there was also aurora, auroral appearances and streamers having been noticed by various observers; moreover there was corresponding magnetic disturbance at Greenwich. So much thus seems certain. But the question remains, was the special phenomenon—the beam or band of light—the zodiacal light, or was it auroral?

Perhaps I may now be permitted to give some particulars concerning an appearance, certainly auroral, seen by myself many years ago, on 1847 March 19. At 7^h 30^m P.M. on this day a bright aurora with streamers was visible behind clouds in the north, which increasing cloud soon hid from sight. At 8^h 45^m a singular and brilliant band of light appeared suddenly, extending from the western horizon upwards across the zenith to 20° or 30° beyond. It was of a whitish colour. At 8^h 55^m clouds partly concealed it from view, but these soon again cleared away, leaving the beam very much brighter, it appearing also to be moving towards the south, passing now some 20° to the south of the zenith. Clouds appearing gradually hid it from view, and at 9^h 30^m it was no longer visible. At 10^h 30^m the sky was again pretty clear, with aurora still visible in the north showing brilliant streamers, but the band of light was not again seen. I give this note in full since it has not previously appeared in print. There was corresponding disturbance of the magnets at Greenwich: see 'Greenwich Observations,' 1847, page [10]. At page (220) of the same volume observations of the aurora and of the special band are to be found, as observed at Greenwich, Cambridge, and at Playford near Ipswich. One observer speaks of the special appearance as "a brilliant band or zone of light." Another remarks that "the permanence of its character separates it from the class of streamers." Others described it as "of a silvery white" and as "perfectly white," and one remarked that the "streak" was "similar in some respects to the great stream of light which was visible about 16 or 18 years since," also that it occupied "the same portion of the sky." One observer describes the band as reaching from the eastern to the western horizon, passing across the zenith. The width was given by different observers as from 2° to 3½°, and several of the observers noted the motion southward.

It will be now apparent that, although the aurora frequently manifests itself in streamers of somewhat evanescent character, which shoot upwards with a flickering motion to a considerable altitude, there are also occasions when isolated beams are seen rising also to a considerable altitude, without that flickering or rapid motion so often observed, but rather remaining visible for some time, and showing much more gradual changes of position and form.

Bearing in mind what has been said, let us now review the observations of 1896 March 4. The only circumstance that seems directly to connect the bright beam with the zodiacal light is the statement that it was observed to be in the axis of the cone of light. This, if suggestive, is not in itself proof of connexion therewith, neither is it proof that the light was not auroral. Further, the beam was narrow, had well-defined edges, gradually varied in length and also in intensity, and appears also to have moved southward. These qualities are not typical of the zodiacal light, but they have all been observed in the aurora, and, as before mentioned, later in the evening aurora was certainly seen.

Now let us compare the facts observed regarding the appearance of 1896 March 4 with what was recorded of that of 1847 March 19. The month was the same; the hour of the evening was similar; the position of the beam in the sky, its width, definition, and comparative permanence (as compared with ordinary auroral streamers) were also similar. And both appear to have had a movement southward. Also, on both occasions, there was in addition aurora with streamers as usually seen, and corresponding magnetic disturbance was observed at Greenwich.

It is further interesting to note that Dr. Kreutz ('Monthly Notices of the Royal Astronomical Society' for April) speaks of an appearance very similar to that of 1896 March 4 ("eine ganz ähnliche Erscheinung"), as having been seen at Kiel on 1895 March 13, in the west-north-west, which was taken to be auroral. On this occasion also there was magnetic disturbance at Greenwich.

There are two periods of the year at which in our latitude magnetic activity is greatest (more especially near the epoch of a sun-spot maximum, now not long passed). These are near to the time of the spring equinox, and, again, near that of the autumn equinox. In summer and winter the magnetic activity is diminished. (I am not here speaking of the diurnal magnetic variation, which in our latitude is in all years greatest in summer and least in winter, but of their regular magnetic disturbance.) The dates we have been considering—March 4, 13, and 19—are all at the period of spring magnetic activity.

If, now, I have interpreted aright the observations of 1896 March 4, I think that we can hardly resist the conclusion that the "curious light" then seen was certainly auroral.

I may add that (unless otherwise indicated) any statement or quotation here given referring to observed facts will be found in one or other of the publications mentioned at the beginning of this paper. WILLIAM ELLIS.

On a Relation between the Spectrum of Hydrogen and Acoustics.

WITH regard to Messrs. Runge and Paschen's successful classification of these elementary spectral lines in series, it is perhaps hardly correct to say that no approach to a physical explanation of the series has yet been arrived at; and I would like in comment on that observation made in Mr. Maunder's most admirable and suggestive discourse *, to direct attention to an acoustical problem which I had accidentally been led to solve just before the announcement, in 1886, of Dr. Balmer's law of the hydrogen-lines, with results which struck me then, and which I have never since doubted, will probably furnish us in some form with a real explanation of the law.

If an open air-pipe is sounding its mth harmonic note, will resonance of that harmonic order still be possible in the pipe, and how much will the pitch of its note alter, if wind of any speed blows through the pipe? The answer to this question is, that taking n any whole number $\ngtr m$, if the wind's speed is $\frac{n}{m}$ths of the velocity of sound in air, and if the pipe is shortened by $\frac{n^2}{m^2}$ths of its original length, the moving column of air in the pipe can still be thrown, by the same note as before, into a stationary undulation of m vibrating segments. But if, instead of shortening the pipe, its length is kept unaltered, then the m segments in which it can vibrate with that air-speed will emit and respond to a note whose frequency or pitch bears to that of the original ordinary harmonic of the same order in the tube exactly the ratio, $1 - \frac{n^2}{m^2} : 1$, which, if we write $n = 2$, multiplies the fixed pitch, A, in the series of lines

$$\frac{1}{\lambda} = \left\{1 - \frac{4}{m^2}\right\} A,$$

of Balmer's law.

Take, next, a flute with open ends, and bend it into a circle till the ends meet, so that the air within can course round and round the tube with any required wind-speed. When sounded at rest by blowing over a side-orifice of the tube in the usual way, this tube's ordinary harmonic notes are all identical with those of an open tube half as long (the tube's two halves behaving simply as two such successive open tubes following each other), and the above solution shows that for any ordinary harmonic note m sounded in the whole tube, as in either of the half-circuits, with the air at rest (which is also expressible as $\frac{m_2}{2}$, in terms of the even numbers of vibrating segments, m_2, which the tube then contains), the air's wind-speed must be $\left(\frac{1}{m} \text{ or } \frac{2}{m_2}\right) \times$ that of sound, to obtain stationary undulation in the circular tube, of its natural mode and rate of oscillation, m; and that the effective pitch of the note which is then sounded is $\left\{1 - \frac{4}{m_2^{\,2}}\right\} \times$ the pitch of the same harmonic note in the tube with the air at rest. A circular revolving ring of fluid, rather than a stream of fluid through a straight tube, thrown into resonance, and emitting vibrations from a lateral point of its circumference, seems thus to be the true construction of a vibrating atom which conforms perfectly to Balmer's law; and the three series of lines found by Runge and Paschen in the spectra of the alkaline metals, and of helium and the helium companion, would thus seem to indicate three ring-clusters interlacing, among whose circuits, of all possible velocities, only those speeds are perceivable by the spectroscope which fulfil the conditions of resonance in their circuits in 1, 2, 3, or more stationary wave-length undulations along them.*

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* See page 221.

[* Terms in the hydrogen-line series having even values, m_2, of m, in the denominators, of their fractions $\frac{4}{m^2}$ are thus perfectly accounted for by resonances of a circular tube's ordinary mode of side-aperture vibration, when flows of the elastic medium circulate in it at $\frac{1}{m}$th (or $\frac{2}{m_2}$ths) of the medium's ordinary wave-speed; but to complete the series with odd values also of m_2, it would be necessary to assume that such a tube can vibrate also with an odd number, m_1, of whole segments round its circumference, and with an air-speed still just similarly related to m_1 as before. With the even multiple, 2, here adopted, of the tube's normal air-speed $\frac{1}{m_1}$, or $\frac{1}{m_2}$, this is an incompatible postulate with coursing conditions, just as it would be with a stationary condition of the fluid in the pipe, because when there is an odd number of nodes in an open unbent pipe, when the air is either at rest or coursing through it at twice the normal speed for that node-number, instead of oscillating co-directly at the tube's two ends, so as to allow the two ends to be joined together concordantly, the air's motions at the two ends of the tube are oppositely directed—either both inwards or both outwards simultaneously,—and they would therefore conflict with each other when the tube's two ends are brought together; and some physical condition outside of the acoustical theory itself must therefore be looked for to supplement its action and to enable it in some more suitable conditions to supply the odd-numbered series of lines missing from this explanation. I have not yet been able to discover any such construction; but the ease with which the vortex-theory of velocity, as described below, appears to remove one main difficulty which attends this attempted mode of explanation, allows good hopes to be entertained that in the nature and behaviour of light-waves, and in the theory of the structures of vortex-rings, some properties will be found and noted which may suffice to fill up a blank in this description, with respect to the remaining unexplained odd-numbered terms of the hydrogen-line series. But without such aid of any physical construction, node-numbers taken only even, as m_2, coupled with air-speeds in the tubes always fourfold the normal ones, or $\frac{4}{m_2} \times$ the ordinary wave-speed, will, I perceive just now, include satisfactorily in the acoustic theory itself the odd-numbered as well as the even-numbered members of the Balmer series.—*Note*, May 28th, 1896. A. S. H.]

Now that an electro-magnetic view is taken of the nature of light and etherial radiations, the annular vortices also now generally regarded as composing atoms' structures may, perhaps, not inappropriately, be likened to gramme-rings endowed with annular as well as with vortical rotations *, and in the gramme-ring we may notice that the current is drawn off, as in such sounding-tubes as here described the vibrations are emitted, from side-points of its revolving circle. The resemblance, too, between the wave-phenomena of sound and of light, in general, is not so very distant, but that an acoustical property like that described may fairly be expected to have a parallel or counterpart corresponding very closely to it in optics. A. S. Herschel.

[* The ratio, $1-\left(\frac{2}{m}\right)^2$, affecting the natural pitch, mA, of a ring-tube's mth harmonic (A being the pitch of the tube's natural lowest note) yields a series by varying m, if the length of the sounding-tube is constant, which by itself alone differs very far from Balmer's line-array, because that ratio multiplies a successively changing wave-frequency, mA, instead of a fixed one, A, as in Balmer's law. To bring the theoretical series into agreement with the observed one, it would suffice to postulate that, by the action of some physical condition, only one in every m of the tube's internal oscillations receives and emits external impulses, since then the exciting or the emitted wave-frequency would only be $\frac{1}{m}$th of that in the tube, and the elimination of the intruding factor m from the theoretical series of ratios might be supposed to be thus naturally effected. I have not been successful in trying to devise some construction which might be thought physically efficient for this purpose; but if instead of supposing resonance to occur in streams revolving, like the iron armature in a gramme-ring, along the core of a ring-vortex, the resonant ring-tubes are supposed to be the fluid stream-lines themselves of the vortex-ring, then it seems probable that such tentative hypotheses may all actually be quite unneeded, for in those stream-lines (at least in the near vicinity of the core, where they are circular) the velocities of flow are inversely as the radii or circumferences of the stream-circles. As the velocities diminish (or as m increases) in the widening circles, therefore, so do the numbers (m) of wave-lengths into which the ring is stationarily divided, increase also; so that these harmonic wave-lengths are all *of constant length* throughout the vortex, and would therefore have, were the fluid along the streams at rest, some *constant* wave-frequency or pitch A, throughout, which is then changed to $\left\{1-\left(\frac{2}{m}\right)^2\right\}A$, as in Balmer's series, in the different ring-streams whose speeds of flow are $\frac{2}{m}\times$ the velocity of light in the luminiferous ether at rest, which is supposed to be the flowing substance of the atomic vortex-rings. One can scarcely help concluding, from the very consistent evidence which all these reflections seem to offer, that it is the natural resonance of the streams of revolving ether in ring-vortices of vortex-atoms' structures, which is visibly represented by the series of lines met with in the spectra of so many metallic elements, all agreeing perfectly in their wave-length processions with the law of progression detected first by Balmer in the complete array of the spectral lines of hydrogen.—*Note*, May 19th, 1896. A. S. H.]

Mr. Hough's Researches on the Periodic Law of Latitude-variation.[*]

THE discovery of the periodic law of latitude-variation, due mainly to the researches of Dr. S. C. Chandler, has given rise to several attempts to reconcile theory with observation, by including in the dynamical theory of the Earth's rotation possible effects of change of form or of the mobility of the parts of the Earth. In the 'Astronomical Journal,' No. 345 (see 'Observatory,' August 1895), Prof. R. S. Woodward has employed the equations of motion of a body of changing form to show that the flow of the Earth's material relatively to its principal axes may give rise to a considerable modification in the duration of the Eulerian cycle, but the equations used are powerless to give any indication of the extent of this modification, or, in fact, even of its sign.

In recent papers Mr. S. S. Hough, Isaac Newton Student in the University of Cambridge, has endeavoured to evaluate the disturbing angular velocities and the consequent modifications in the period on two different hypotheses as to the constitution of the Earth. In the former the interior of the Earth is assumed to be in part fluid, while the outer crust is treated as rigid. The results, however, are of a negative character, showing that such a constitution would lead to a phenomenon in direct contrast to that which is observed, namely a shortening instead of a lengthening of the period. In the second paper, the Earth is regared as solid throughout, but the material of which it is composed is supposed capable of elastic distortion. The difficulties of the mathematical treatment necessitate the neglect of possible variations in the density and elastic quality of the Earth's material, and the case considered is, therefore, that of a homogeneous spheroid composed of isotropic, incompressible material. Such a spheroid, if of the same size and mean density as the Earth, the external figure being such that it is free from strain in its interior when rotating uniformly in a sidereal day, would oscillate, if rigid, in a period of 232 days. If, however, the spheroid be composed of elastic material of the same degree of flexibility as steel, it is estimated that the period would be prolonged to 335 days; but assuming that the effect of heterogeneity is to further prolong the period in the ratio 305 : 232, the period for the actual Earth supposed of the rigidity of steel is estimated as 440 days. It is therefore concluded that the observed extension from 305 days to 427 days may be adequately accounted for by supposing that the resistance to distortion of the solid parts of the Earth is rather greater than that of steel.

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[*] "On the Oscillations of a Rotating Ellipsoidal Shell containing Fluid," Phil. Trans. 1895 A, and "On the Rotation of an Elastic Spheroid," Proc. Roy. Soc., March 1896.

The latter problem has been previously treated by Prof. Newcomb ('Monthly Notices,' March 1892), who gives a simple geometrical explanation of the phenomenon. Mr. Hough enters into a full analytical discussion of it, which confirms in the main the procedure of Prof. Newcomb, but discloses a slight error in its details.

Another cause which may tend to modify the Eulerian period is to be found in the mobility of the ocean and of the atmosphere. The inclusion of the effects due to this latter cause will of course lead to a modified estimate of the Earth's rigidity. According to Newcomb the period of the latitude-variations will be longer with the ocean in its actual condition than it would be if the ocean were rigidly attached to the solid Earth, and consequently the extension of the Eulerian period is to be explained only in part by elasticity. We should therefore obtain an increased estimate of the Earth's rigidity. In Mr. Hough's opinion, however, Newcomb's conclusions as to the effects of the ocean are not well-established, and further research is necessary to determine the nature of the modification due to this cause. He, however, accepts the view that the chief factor which accounts for the prolongation of the period is elasticity, and that the estimate of the Earth's rigidity deduced from Chandler's period without taking account of the ocean, will not be modified to any considerable extent when the effect of the latter is included.

Selenographical Notes.

THE ARIADÆUS CLEFT.—Though this familiar object is for the greater part of its length one of the coarsest of lunar clefts,—easily glimpsed under a low Sun with a good 2-in. achromatic,—to appreciate the true character of the great chasm with all its manifold details requires not only an exceptionally perfect night, but an instrument of large aperture with high powers.

From the date of its discovery, more than a century ago, by Schröter of Lilienthal, it has been keenly scrutinized by Mädler, Schmidt, Webb, and many other renowned observers of lunar detail, and its peculiarities described; but to the last must be given the credit of drawing attention to the most striking feature in connection with it,—viz. its duplication, or rather the overlapping of what are apparently the ends of the eastern and western sections, about two-thirds of the way between the little crater Ariadæus and Silberschlag.

Webb's discovery of this curious structural arrangement was made in 1861, and is fully described in the 'Intellectual Observer,' Vol. xii. p. 102, where he remarks—"How so apparent a feature should have escaped all previous observers, and even Schmidt himself, is not easy to understand; but it proves how much yet remains to be done for the topography of the Moon." It may be said, however, on behalf of Schmidt and others, that, so far as my experience goes, this duplication, or even the indications of it, except on extremely favourable occasions, is by no means so easily seen as Webb asserts, at any rate in "common telescopes." In the 'Observatory,' Vol. xii. p. 110 *et seq.*, I described the results of a critical examination of the rill in 1888, with the great Lick Telescope, by Prof. Holden and Mr. J. E. Keeler, in which Webb's statement is supported so far as the breach of continuity in the cleft is concerned, but not as regards the overlapping. In Prof. Holden's drawing, the eastern, or Silberschlag, section of the cleft terminates at what appeared to be, on Dec. 11, 1888, a bright spot,—a portion of an old crater-ring which the cleft traverses. The western, or Ariadæus, section begins at a hill separated from the termination of the first section by a little more than the width of the chasm and lies nearly due south-west of it. It was also apparent that the eastern section differed slightly in direction from the western, tending more towards the north.

Quite recently I have received, through the courtesy of Lieut. P. B. Molesworth, R.E., the results of his examination of the cleft and its neighbourhood at Hong Kong, in August 1892, with a 9¼-in. S.O.G. reflector by Calver, which are not only of great interest as regards its minuter features, but as confirming Webb's observation of the overlapping portions. With a power of 375, on the evening of August 13, he noted the eastern section of the rill at the place in question traversing a mountain mass, which lies on its southern side, as a wide irregular chasm, bending slightly towards the north, and thinning out to less than half its width after passing through the mountain, and then suddenly terminating. The western section, less wide, but also curved in the same way, is more regular in breadth, and gradually thins out to invisibility on the east. Between these overlapping grooves there is a slight ridge, which, judging from the sketch before me, appears to have been a very obvious feature. The difference between Webb's and Molesworth's drawings, which in other respects are tolerably concordant, is that the latter shows the overlapping part of the eastern cleft as much broader, instead of much narrower, than the western, and exhibits the sides of both chasms as very irregular. The rock, bridging the western division of the cleft at a point about one-third the distance between Ariadæus and Silberschlag, and which, as Prof. Holden points out, is a part of a large degraded crater, is described by Molesworth as a short high hill. Between this and the overlapping length lies a group of mountains of some intricacy, through which the rill cuts without apparently any modification in breadth, but, what is noteworthy, it displays here a short bank or elevation midway, dividing it into two narrow channels. In its progress through (if not partially over) the Silberschlag range, it is shown by Lieut. Molesworth as following a serpentine course, while its breadth appears to be less than one-fourth of what it is on the neighbouring plain to the west.

The convexity of the floor of the cleft, west of the hill which bridges it over, and its extension towards Ritter *d* (which seems to involve a second instance of duplication) are points which, doubtfully asserted by Molesworth, must be left for future confirmation.

As a proof of the excellence of the night on which these observations were made, it may be stated that sixty craterlets are shown on the plain south-east of the cleft, and at least as many more were observed, but not inserted in the drawing. Of these five, of a very minute type, lie on the southern glacis of Whewell, eight surrounding a good-sized, but unrecorded ring N. of Whewell, five round Cayley B, and the rest pretty evenly distributed in the region between the southern side of the cleft and a line joining De Morgan and the Silberschlag range. It will be interesting to see how many of these little objects will be discovered under the process of photographic enlargement.

Beaumont House, Shakespeare Road,
Bedford, 1896, May 19.

T. GWYN ELGER.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

The Eclipse of A.D. 393.

GENTLEMEN,—

In my letter to you of the 6th of January last (No. 237, p. 91) I stated that Zosimus alone amongst the ancient historians speaks of an eclipse of the Sun as having occurred during the battle between Theodosius and Eugenius; and as all the other historians mention a violent storm at the time as having contributed to the final victory of Theodosius, it is probable (as remarked by Clinton) that Zosimus inadvertently recorded an eclipse instead of a storm. Professor Stockwell, however, taking it to have been an eclipse, and finding none which would at all answer the conditions but this of A.D. 393, November 29, proposes to antedate the accepted date of the battle by nearly a year. The objection to this is, as I pointed out in my letter, that the contemporary historian, Socrates, gives September 6 as the date of the battle—a much more likely season, I may remark, than the end of November for the region, close to the Alps, in which it was fought, and also giving more time for the subsequent events recorded before the death of Theodosius in the following January.

In No. 372 of the 'Astronomical Journal' (of which he has kindly forwarded me a copy) Prof. Stockwell virtually traverses my statement that Zosimus is alone amongst the ancient historians in speaking of an eclipse at the time of the battle, by saying, in a note to his interesting article on Eclipses and Chronology, that Ammianus Marcellinus and Prosperus Aquitanus also connect the battle with an eclipse. Now all those who are familiar with the history of those times will remember Gibbon's encomium on the trustworthiness of Ammianus Marcellinus as an historical guide. But it so happens that he fails on this occasion. His history terminates with the death of the Emperor Valens in A.D. 378, and he probably died in A.D. 380, thirteen or fourteen years before either the eclipse or the battle. Prof. Stockwell takes his information from the late Prof. G. Seyffarth, whose reference is not to Ammianus Marcellinus, but to Marcellinus Comes, a later and very inferior writer. His statement agrees so closely with that of Prosperus Aquitanus, that it is probably taken from the latter. It is not quite certain whether an eclipse is mentioned; the words are "hora diei tertiâ tenebræ factæ sunt." But the decisive point in the matter of which we are treating is that both chroniclers place the "tenebræ" in the year before the war between Theodosius and Eugenius; so that if caused by the eclipse in question, the battle occurred on the date usually accepted (A.D. 394), and the death of Theodosius in A.D. 395.

Yours faithfully,

Blackheath, 1896, May 12. W. T. LYNN.

Sarrabat and the Comet of 1729.

GENTLEMEN,—

This comet was discovered at Nismes by Father Sarrabat, Professor of Mathematics at Marseilles, on the 31st of July. Soon afterwards he ceased to be able to see it on account of the increasing moonlight; but succeeded in observing it during the eclipse of the Moon on the 8th of August. Cassini did not receive intelligence of the discovery until the 26th of that month. When he saw it he was surprised at the place being so near that reported at the time of discovery nearly a month before, and, till he had followed its motion himself, doubted whether it were really a comet. It was barely visible to the naked eye; but he succeeded in continuing his observations until the 18th of January, 1730.

Cassini recognized the great distance of the comet from the Sun, but seems to have thought that the orbit was nearly circular and quasi-planetary. Considering that its mean distance from the Sun was about 4·8 that of the Earth, he concluded that it was revolving round the Sun in a period of about ten years. More refined calculations have shown that the orbit is parabolic or even (according to Burckhardt) hyperbolic. The perihelion distance from the Sun is much greater than that of any other known comet, being about 4·05 on the scale of the Earth's mean distance from the Sun, which is only 1·15 less than the mean distance of Jupiter. Nicolas Sarrabat, it may be mentioned, the discoverer of this comet, died a few years after the discovery, at a comparatively early age, whilst on a visit to Paris; but the exact date of this seems somewhat uncertain. Three of his dissertations—'Sur les variations de l'Eguille Aimantée,' 'Sur la cause de la Salure des Eaux de la Mer,' 'Sur les causes et les variations des Vents'—gained the Prize of the Académie Royale des Belles-Lettres, Sciences, et Arts de Bordeaux. Poggendorff seems wrongly to attribute to him another, 'Sur le Mouvement de la Seve dans les Plantes,' that being by M. De la Baïsse. His astronomical observations are stated in the 'Biographisch-Literarisches Handwörterbuch' to be given in the 'Mémoires' of the Montpellier Society; but I have failed to find any there by him. Perhaps I may add that though Cassini spells his name Sarabat, in which he is followed by later writers, Sarrabat in his own papers always spells it as above. Yours faithfully,

Blackheath, 1896, May 2. W. T. Lynn.

OBSERVATORIES.

Oxford University Observatory.—The annual Visitation of this observatory took place on Wednesday, May 6, when the Savilian Professor presented his Report to the Visitors, for the period 1895 May 26 to 1896 April 30, from which we extract the following information.

The De la Rue Astrographic Telescope is in good order and has been in constant use throughout the year. The De la Rue Reflector is in good order, but has only been used occasionally for gazing purposes. The Barclay Transit Circle has performed very satisfactorily since its return from Messrs. Troughton and Simms, and has been continuously used throughout the year for determining time.

The mounting of the 12-inch mirror presented by Dr. Common has advanced so far that it is ready for trial; but preparations for the eclipse of next August have not as yet allowed time for the trial. The "Artificial Sky" described in the last report has been used by several students for practice in observing transits and is in good working order. The Astrographic Micrometer has been in constant use throughout the year and another of precisely similar pattern was purchased in January last, so that two observers can now work simultaneously. The revolving Sector for photometric measures has been mounted in the basement and is nearly ready for the examination of photographs of eclipses and nebulæ.

The Astrographic Catalogue was the chief subject of work during the period covered by the Report; 265 plates have been taken, making the total number up to 752 out of the 1180 required. Ninety plates containing 23,793 stars have been completely measured, which brings the total number of plates measured to 136.

It is mentioned that some of the plates which cover fields in the Milky Way have as many as 1000 stars on them, whilst others in a different region have as few as 70. Much necessary work preliminary to the reductions of these plates has been accomplished and the plate constants for 12 plates deduced.

Two series of plates of the planets Pallas and Eunomia have been taken to test the suitability of the photographic method for determining planetary parallax, with encouraging results.

Under the head "Lectures," Prof. Turner makes a statement of the courses of instruction delivered during the year, and shows that the interest taken in astronomy by members of the University is increasing, an interest which it is his desire to foster.

WINDSOR, NEW SOUTH WALES.—The annual report of this private observatory always contains a surprisingly large amount of observations, remembering that they depend on the work of only one man, and the copy for the year 1895 shows that Mr. Tebbutt is not in any way relaxing his astronomical energy. A large part of the little book is taken up with records of the transit observations made to determine the clock error. The number of transits of clock stars observed was 957, on 184 nights.

The chief work of the observatory was, however, the observation of occultations of stars by the Moon, of which sixty-five phases in all were observed, forty-six disappearances and nineteen reappearances, including the observation of disappearance and reappearance of a star of the 5th magnitude in full sunlight, which was recorded in detail in the number of this magazine for last November. Other observations with the 8-inch equatorial include filar micrometer measures of position of Jupiter, Saturn, and Venus, compared with large stars with which they were respectively in conjunction, and similar observations of small planets. Mr. Tebbutt has also continued his series of double-star observations, and worked at these on 45 nights, the results of which will no doubt be published, as were those for 1894, in the 'Monthly Notices.' The usual meteorological observations have been made as before, and the abstract of the results of these for the past five years will shortly be printed.

NOTES.

COMET NOTES.—Swift's Comet was very conspicuous at the end of April and beginning of May, and numerous observations are reported. Dr. Schorr on April 24 saw two tails, the shorter and brighter towards the south-east, the longer and fainter (4′ in length) towards the north-east. On April 28 he could only see the latter of these. The spectrum of the comet was observed at

South Kensington on April 28, and was found to consist of three bright bands due to carbon, there being practically no continuous spectrum. The comet was seen on that night with an opera-glass.

The following revised elements are given by Dr. Schorr in Ast. Nach. 3349:—

T=	1896 April 17·6766 Berlin M.T.	
ω	1° 42′ 38″	1896·0.
☊	178 17 12	
i	55 32 38	
log q	9·75321	

Ephemeris for Berlin midnight.

	R.A. h m s	N. Dec. ° ′		R.A. h m s	N. Dec. ° ′
May 31....	23 29 37	72 33	June 12....	22 10 32	72 40
June 4....	23 2 40	72 49	16....	21 45 44	72 15
8....	22 36 0	72 53	20....	21 23 6	71 40

Brightness on May 31 and June 20, 0·10 and 0·04 of that at discovery, respectively.

Almost identical elements are given by Rev. G. M. Searle in Ast. Journ. 373.

M. Schulhof publishes in Ast. Nach. 3351 the following hyperbolic elements of Comet 1896 I. (Perrine-Lamp).

T=	1896 Jan. 31·84870 Paris M.T.	
ω	358° 31′ 55″	1896·0.
☊	208 54 19	
i	155 44 31	
log q	9·769114	
e	1·00358	

The hyperbolic nature of the orbit is still uncertain. The above result, however, makes it certain that the orbit is not an ellipse of short period.

This comet was photographed at Prague several times during March. On March 3 a long slender tail 2° long, in position-angle 35°, appeared on the plate; on March 12 no tail could be traced. The comet was observed up to April 16, but was then extremely faint and ill-defined.

The following search ephemeris of Comet 1889 V. (Brooks) is by J. Bauschinger (Ast. Nach. 3350):—

	R.A. h m s	S. Dec. ° ′		R.A. h m s	S. Dec. ° ′
May 27....	22 1 26	19 49	June 14....	22 20 45	18 46
June 2....	22 8 25	19 25	20....	22 25 57	18 32
8....	22 14 53	19 4	26....	22 30 27	18 20

The following definitive elements of Comet 1890 IV. (Zona) are by A. Venturi (Ast. Nach. 3351):—

T = 1890 Aug. 6·91990 Berlin M.T.

ω	331° 15′ 4″
☊	85 22 5
i	154 18 27
e	0·99587
log q	0·311053
Period	11040 years.

120 observations are utilised, from which four normal places are formed. The above orbit represents the normal places very satisfactorily.

Comet 1895 IV. (Perrine) was photographed at Prague on March 15 and 20. No tail could be traced. It was observed at Strassburg on May 6. The following ephemeris is for Berlin midnight:—

	R.A. h	m	s	N. Dec. °	′
May 29	18	2	55	23	37
June 4	17	50	4	23	57
10	17	37	33	24	1
16	17	25	42	23	53
22	17	14	45	23	32
June 28	17	4	48	23	1
July 4	16	56	0	22	22
10	16	48	21	21	37
16	16	41	50	20	48
22	16	36	26	19	56

MINOR PLANET NOTES.—A new planet—CS—was discovered by Charlois on May 4, and another one—CT—by Wolf on May 8.

Planet (340), discovered by Wolf 1892 Sept. 25, has been named Eduarda.

Ast. Nach. 3346 contains a discussion by Martin Brendel of the gaps in the zone of minor planets corresponding to commensurability with Jupiter's period. His results show that planets cannot permanently have mean daily motions between 593″·3 and 603″·8, nor between 443″·8 and 451″·9.

The following planets approximate to these values:—(168) Sibylla 573″, (401) Ottilia 584″, (332) Siri 605″, (122) Gerda 614″, (108) Hecuba 616″, (153) Hilda 451″, (190) Ismene 452″.

Ast. Nach. 3349 contains tables for computing the perturbations by Jupiter of the outer minor planets, with special reference to the case of (153) Hilda.

Ast. Nach. 3352 contains elements of planets (318) Magdalena and (325) Heidelberga by A. Berberich. The periods of both these planets are about half that of Jupiter, their mean daily motions being 621″ and 616″ respectively as compared with 299″ for Jupiter.

DR. KRUEGER.—Carl Nicolaus Adalbert Krueger was born at Marenburg, in Prussia, in 1832, was educated at Elbing and at Wittenberg, and after completing his academic course at the Berlin University was appointed, at the age of 21, Assistant at the Bonn Observatory, then under the direction of Argelander. Here, with Schönfeld as his colleague, he worked chiefly at the well-known 'Durchmusterung,' and their names appear with that of Argelander on the titlepage of that immortal work. In 1862 he was appointed Director of the Helsingfors Observatory, where during the period 1869–1876 his principal care was the meridian observation of the Zone +55° to +65° for the star catalogue of the 'Astronomische Gesellschaft'; and when in 1877 he was transferred to the directorship of the Gotha Observatory, he continued and completed this work with the same instrument that he had used at Helsingfors.

Besides his work on these two great catalogues, Dr. Krueger is the author of many other investigations of a less routine character. We like to remember that his dissertation for the degree of Doctor was on "The Right Ascensions of Stars observed with Flamsteed's Mural-circle." Whilst at Bonn he made determinations with the Heliometer of the parallaxes of the stars 70 Ophiuchi, Lalande 2156, and O. Arg. 17415–6. With the same instrument he made a survey of the stars in the cluster *h* Persei, and at Helsingfors he published a research on the orbit of the small planet Themis, made with the purpose of determining the mass of Jupiter. The result showed that the then received value should be increased by its 68/1,000,000 part, a value intermediate between those found by Airy and by Bessel of the same quantity. Many other computations and mathematical investigations relating to comets, small planets, and variable stars are due to him.

In 1880, on the death of Dr. C. A. F. Peters, Director of the Kiel Observatory, Dr. Krueger was chosen to succeed him in this office, and shortly after he was asked to take up the editorship of the 'Astronomische Nachrichten,' which, from its hundredth volume, was published under the auspices of the Astronomische Gesellschaft; but there is reason to think that, though it was thus a semi-official publication, Dr. Krueger had quite independent control of this indispensable journal, and that its successful appearance during the last sixteen years is due entirely to him. After being a few years at Kiel the "Centralle Stelle für astronomische Telegramme" was established, we believe, on the proposal of Dr. Förster of Berlin. but the establishment and administration has been in the hands of Dr. Krueger, with the success which is known to all astronomers.

Before leaving Bonn, Dr. Krueger married the daughter of Argelander, his first chief, who survives him. Their daughter, following her mother's example, has married an astronomer, Dr. Kreutz. It has not been our good fortune to make the personal acquaintance of Dr. Krueger, but we have had vividly described to us the genial welcome which has been accorded to foreign astronomers visiting Kiel by the Director and his wife, and we have been told of an arch remark of Mrs. Krueger, that "the Doctor and she divided astronomers into two classes, those who subscribed to the 'Nachrichten' and those who did not,"—as instancing the interest they both took in the work. It is not recorded whether the fact made any difference in the welcome.

Dr. Krueger had been failing in health for some years; he died at Kiel on April 21 last.

We tender our sincere congratulations to Dr. A. M. W. Downing, Superintendent of the 'Nautical Almanac,' on his election to the Fellowship of the Royal Society, a well-deserved honour, and also to Mr. W. E. Wilson, of Daramona, Streete, Ireland, who has been elected to a similar honour. Mr. Wilson has been actively engaged in astronomy at his private observatory for the past twenty-five years, and has published many valuable investigations of a physical character, on such subjects as the radiation and absorption of solar heat, and on photography and photometry. We also have to offer our congratulations to Dr. Gill, F.R.S., H.M. Astronomer at the Cape, whose name appears in the list of birthday honours under the head "Commanders of the Bath."

Some new Features of the Saturnian System.—In a recent number of the 'Comptes Rendus' (April 27) M. Flammarion gives an account of some markings recently seen on Saturn by M. Antoniadi, his assistant at Juvisy, which leads him to a conclusion relative to the dynamics of the system. M. Antoniadi has, in fact, seen three divisions of the bright inner ring, which thus divide this ring into four. He suspected the appearance of these divisions as far back as 1895 July 8, but bad weather and the nearness of the planet to the horizon did not allow him opportunity to confirm the observation. He says that on April 18 of this year the aspect of the lines was such as to leave no doubt as to the reality of their existence, and the appearance is thus described:—"The middle ring (B) shows in its central region a well-marked division, and on one side and the other two divisions less well defined. The first and darkest is seen nearly halfway between the Cassini division discovered in 1675 and the edge of the crape ring discovered by Bond in 1850. It is seen easily when the atmosphere is quite clear. The two others are much finer and are visible only when looked for with the greatest care." Similar appearances have been suspected before. In 1780 William Herschel noted a thin dark line near the interior edge of the western ansa, which disappeared, and a similar marking was then seen on the opposite ansa. In May 1838, de Vico at Rome saw two divisions. In 1851 Bond at Harvard observed several subdivisions, of which one was very large. On January 9, 1855, Coolidge, Bond's assistant, saw three or four divisions on the same part of the ring quite plainly, and in 1875 and 1876 Prof. Asaph Hall suspected the existence of several concentric lines upon the same ring B.

This apparently occasional appearance of the markings has led M. Flammarion to ask the question whether these markings are subjective phenomena due to atmospheric or instrumental conditions, or to personality of the observers; or whether they might not be really separations of the zones of the molecules of which the ring is composed, due to the attractions of the satellites and therefore variable on account of the changing positions of these satellites. This seems to be a problem for the mathematicians.

THE SUN-SPOT CYCLE.—After an unusually pronounced and well-sustained maximum, there has come a sudden and striking diminution of the spot activity of the Sun, which seems to promise that we shall soon be landed in a period of profound quiescence. 1891 was a year of rapid increase; then for the four succeeding years we had an almost unbroken succession of great spot displays; now, for the first time for over five years, days without spots are beginning to be recorded. On April 15, 16, 17, and 29, May 9, 15, and 16, the Sun was completely spot-free—the first time since 1891, March 28—and on the intervening days the spots were usually few in number and insignificant in size.

It may be remembered that the preceding cycle showed an even more remarkable transition from great activity to quiescence. The maximum set in with the great displays of April 1882, and was continued until early in 1886 with very little indication of running down. But from 1886 October 31 to December 9, a period of 40 days, the Sun was left entirely free from spots except on seven days, when two or three minute "pores" were recorded.

THE ASTRONOMICAL CONFERENCE AT PARIS.—Following on the Conference held at Paris for the purpose of discussing matters relating to the Astrographic Chart, an account of which we hope to give in our next number, a meeting was convened to discuss certain fundamental points of geometrical astronomy. This was primarily a meeting of the four Superintendents of the Nautical Almanacs published by England, France, Germany, and America, each of whom had associated with him another representative of his own country. M. Faye, the President of the Bureau des Longitudes, presided at the meetings; M. Loewy occupied the vice-chair; M. Bakhuyzen, Director of the Leiden Observatory, and M. Trepied, of Algiers, being Secretaries. The business to be discussed was the formation of a standard catalogue of stars to be used as fundamental in the computation of the national ephemerides, and the adoption of values of the constants of precession, nutation, and of the solar parallax, which should be used in the same computations. The first of these matters, the formation of the catalogue, was agreed to, and Prof. Newcomb was asked to undertake the work, and the selection of the constant of precession was left in the same hands. The value of the solar parallax 8″·80, deduced by Dr. Gill from his observation and investigation of minor planets, was considered final, and consequently 9″·21 deduced in the same work was taken as the nutation constant. The constant of aberration adopted was 20″·47. The conference also considered that the present limit of astronomical accuracy is represented by a hundredth of a second of arc—that is, it was considered inexpedient to define these constants beyond the second decimal place.

A PHOTOGRAPHIC TRANSIT-CIRCLE.—We are under obligation to Mr. H. C. Russell, Director of the Sydney Observatory, for copies of several papers communicated by him to scientific societies at our antipodes. Some of these, although, they all form evidence as to Mr. Russell's care and ability, are on meteorological subjects and therefore do not specially interest us; but one of them, entitled "Design for a Photographic Transit-Circle," certainly appeals to us, as it, strangely enough, is an attempt to realize a suggestion for eliminating personality in observing transits made in the "Oxford Note-Book" of last month.

Mr. Russell's transit-circle is really an equatorial. A firm and stable mounting of the English form carries a guiding telescope and a camera. The instrument being set in the meridian, the guiding telescope is treated as a transit-circle, and its errors of collimation, level, and azimuth are determined by the usual methods. It need scarcely be added that the circle-reading for meridian position can be determined as level error by observation of the image of a wire reflected from mercury.

Now the guiding telescope being set before meridian passage, it is kept pointed to a star by an electrically controlled clock, and also by the observer, who uses the slow motions to keep the star on the cross wires. At the same time a photographic plate is exposed in the camera. A second person observing with the reading microscope of the R.A. circle, notes the time chronographically when certain divisions of the circle, which is 3 feet in diameter, pass under the microscope. The relation of these divisions to those which mark meridian position being known, it is easy to see that the time of meridian passage can be deduced. But before and whilst the star is passing the meridian, the instrument is reversed, and the plate again exposed to the same field, with the same guiding star, after the meridian. Thus, if the lines of collimation of camera and telescope are parallel and properly adjusted, the guiding star has one image on the plate, and all other stars have two. The times of transit of divisions of the R.A. circle are recorded as before, and hence another determination of the time of meridian passage is obtained.

The plate being afterwards developed, if the images of the guiding star photographed in the two positions of the instrument do not coincide, their difference of position gives a correction for collimation of the camera, and the positions of the other stars on the plate being measured with reference to the guiding star, the transit of all these stars may be deduced; and it may be easily seen that the transit is free from personality in the ordinary sense, but that the personality occurs in observing the circle divisions. The plan is certainly very pretty, though it looks complicated, and we believe it to be new, although it may be rash to say this.

A CHART OF CIRCUMPOLAR STARS.—Another of these works by Mr. Russell is a chart of the southern heavens from the South Pole to the Equator, showing stars down to the magnitude 6·5. This is not intended as a contribution to advanced astronomy, for, as the author says, there are already many such charts well suited to the wants of students and observers, but is intended to teach beginners the stars, and the endeavour has been to show the heavens as they are seen, and hence the map is not crowded with details. The Magellan clouds have been put in, copied from actual photographs, and also all the star-clusters which one could see under favourable circumstances with a three-inch telescope. The diameter of the map is 30 inches, and a small reproduction is bound up with the accompanying descriptive pamphlet.

THE SPOTS AND MARKINGS ON JUPITER.—Prof. Hough's paper on the "Spots and Markings on the Planet Jupiter," in the 'Astronomische Nachrichten,' No. 3354, is not only important for the mass of measures contained in it, but being the continuation of a series of measures made each year since 1879 it has special value. We believe that, of the vast number of observers of Jupiter's surface, Prof. Hough stands apart, by reason that he has now a continuous record not of drawings only but of micrometric measurements of the salient features of the planet. Such measures are of far more value than drawings made without the aid of a micrometer. It is not so long since that, in a discussion on the variation of latitude of the belts, one of the foremost speakers acknowledged he had not seen Prof. Hough's measures. We hope all interested in surface-markings of Jupiter will read Prof. Hough's papers. Prof. Hough uses an 18½-inch refractor.

THE SYSTEM OF CASTOR.—In observing the spectrum of α Geminorum with the great refractor of the Poulkova Observatory, and the two-prism spectroscope in 1894, Prof. Belopolsky noted that the velocity in the line of sight did not remain constant, and suspected a periodic movement of the star, besides that of its motion about its well-known companion α_2. He had not opportunity to investigate this matter until last January, when he obtained a series of measures of velocity by Vogel's method, which he has published in Bull. de l'Acad. Imp. des Sci. de St. Pétersbourg for March. The number of observations is too small to determine an orbit with accuracy, but M. Belopolsky suggests, as an approximate conclusion, that the star revolves about a dark companion in a circular orbit in a period of 2·98 days, and that it passed through perihelion on 1896, Feb. $27^d\ 5^h$; and assuming that the whole system is moving from the Earth with a velocity of 1·0 leagues per second, this fits his observations with some approach to accuracy. But we feel bound to say that deductions of short periods of this kind always require corroboration.

MIRA CETI.—This variable star, *o* Ceti, has again justified the epithet applied to it. Its maximum brightness was predicted for Dec. 9 of last year, but observers agree in noting that the actual maximum did not happen until about two months later. Miss Rose O'Halloran records the maximum as lasting from January 21 to February 6. M. Bruguière at Marseilles observed the star to have its greatest brilliancy from January 20 to February 1, and similar observations are published by other observers. Deviations from the predicted epoch, based on a period of 331 days, have happened before, but the deviation appears to follow no law. From a short table giving the observed facts relating to the last 12 maxima, published in the Bull. de la Soc. Ast. de France, we learn that four times the time of observed maximum agreed with the predicted; on five occasions circumstances did not permit observations being made with certainty, and on three occasions, which happen to be the three most recent, the maximum did not happen until some time after the date given in the ephemeris.

NEW OBSERVATORIES.—Of the making of observatories as of books there seems to be no end. We hear of three Universities in the United States which are adding an observatory to their foundation, and are having instruments of considerable size made to equip them. The list, with the aperture of their respective principal telescopes, is as follows: University of Ohio, Columbus (12-inch); University of Minnesota, Minneapolis (10½-inch); University of Illinois, Champaign (12-inch). These with the Flower Observatory, Pennsylvania, whose establishment was announced last November, make up four observatories founded in the past twelve months. All the instruments have been ordered of Messrs. Warner and Swasey, and the optical parts from Messrs. Brashear.

Another institution which comes under this head, though its formation is not quite so recent, is the Mont Mounier Observatory, in the Maritime Alps, 8900 feet above the sea-level. This was set up by M. Bischoffsheim in the year 1893, and M. Perrotin has already made a successful series of observations of Venus here;

but we gather from a notice in 'Nature' of May 7, that it is to be used now chiefly as a meteorological station, and that it has been connected by telephone with the nearest telegraph-office, that daily weather reports may be sent to the Central Meteorological Bureau.

REMARKABLE ECLIPSES*.—Mr. Lynn makes excuse for publishing a book on eclipses, when there are already so many, on the ground that "it is only a little one." We remember that this excuse has been made before in a different connection; but certainly no palliation is needed in this case, for the new production, though possibly not actually a necessity, will no doubt be used as a handy reference book by many persons, and, as the author says, in no other book is so much information given on an interesting subject for so small a price.

The little brochure is on parallel lines with Mr. Lynn's previous work 'Remarkable Comets,' and gives in chronological order concise accounts of all solar eclipses, from that of B.C. 776, mentioned in the Chinese records, to that of April 1893, with a short reference to the forthcoming eclipse of this year. About a page is devoted to each of the earlier eclipses, and a slightly longer space to those of more recent date, from which it may be seen that any one may read the complete history of the subject without much intellectual strain. The book comes opportunely, as no doubt the subject of solar eclipses will create some popular interest during the next few months, and this, combined with the fact that it is sold for sixpence, should cause it to have a large sale.

WRITING some pages back of the marrying of astronomers recalls a story of Maedler, the famous selenographer, told in a collection of short historical stories by Baring-Gould, but of which we know no authentic proof. It is related that the wife of a certain Councillor Witte of Hanover was an ardent student of the lunar surface, and had made for herself a beautifully exact and ingenious model of the Moon in white wax. Maedler hearing of this, and having been permitted to see it, was struck with so much admiration for the model and desire for its possession, that he took the only course that seemed to him possible to attain this last—that is to say, he wooed with great difficulty and married the daughter of Councillor Witte, on the understanding that the wax model of the Moon was to be part of her dowry. We wonder if this story has any foundation of fact; and if so, does the model exist now?

THE 'Astronomische Nachrichten' is temporarily under the direction of Dr. Kreutz.

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[*] By W. T. Lynn, B.A., F.R.A.S. Stanford, 1896.

FROM AN OXFORD NOTE-BOOK.

THE following letter, which appeared in the 'Times' for April 14, hits off a characteristic of the metric system rather cleverly:—

"As the Decimal System is under discussion in your columns, will you allow me to call atttention to a view of the matter which residence in France has brought before me, and which I have never seen noticed, though it is, as it seems to me, of very great importance?

"In England, if an old village woman buys a measured quantity involving fractions of an article at a price reckoned, say, in shillings, pence, and halfpence, the shopman or girl never seems to find any difficulty in working quickly in his or her head the sum which has to be paid, and the old woman manages to see that she is charged correctly; but in France, with the Decimal System, it seems always to be necessary to work the simplest sum out on a piece of paper. In fact, it is not difficult to see that it is pretty easy to work out mentally the value of, say, 1¾ yards of ribbon at 3½*d.* per yard, while it is very difficult to work out mentally 1 metre and 75 centimetres at 35 centimes a metre.

"The Decimal System is, therefore, much the less convenient for the petty transactions of life which concern the bulk of the population, and is an advantage only to those who have to deal in numerous large transactions, which have to be booked."

The fact is that there is a great difference between two figures and three; and the fractions used in common life, when expressed in common parlance, are practically equivalent to a single subdivision. One and three quarters is treated like one and a half; but 175 passes into the domain of three figures.

THE National Portrait Gallery, in its new home behind the National Gallery, has been largely visited. In the first fortnight 33,000 people passed the turnstiles, and I was one of them. I went in more especially to see how astronomy was represented, and was a little disappointed. There is a picture of Sir William Herschel, painted by Lemuel F. Abbott in 1785, and purchased for the nation in 1860. Also one of Mrs. Somerville. And this is all the astronomy we get, until we find Newton on the top-floor wedged between Judge Jeffreys and Sir Christopher Wren. I presume that the arrangement is not meant to suggest Newton's connection with the cruelly severe laws and beautiful architecture of the Universe, but is merely chronological. It does, however, call to mind that Wren was an astronomer of considerable reputation; he was, indeed, a very many-sided man, although his name is generally associated only with architecture, and not only filled the chair of Astronomy at Gresham College, but was afterwards Savilian Professor at Oxford. Surely we ought to have some more astronomers in the National Portrait Gallery?

It is well for those who go to see Total Solar Eclipses to remember the possible effect the spectacle may have on a superstitious and ignorant crowd. I remember Professor Tacchini remarking in Grenada in 1886 that it was, even for us who knew so well what would happen, a sight calculated to stir our pulses, and must naturally have a much more perturbing effect on those who had only the vaguest idea of what to expect. The following cutting from the 'Daily Telegraph' (I am ashamed to confess I forgot to note the date) illustrates a rather different view of the matter:—

"In spite of the advance made in the science of astronomy, and the large number of astronomical textbooks published in the Brahmin language, the Hindoo nation shares, on the subject of eclipses, the superstition of the most primitive races. The people believe, for instance, that the lunar eclipse is caused by a gigantic serpent devouring the Moon, a phenomenon they consider to be fraught with ill-omened influence. It might be reasonably expected that the superior castes would be above these superstitions, especially in large towns like Madras, which boast of their flourishing universities and of their European civilization. Such, however, is not the case. The 'vakils,' or Indian advocates, nearly all of whom are Brahmins, have just given a significant proof of its existence. During the sittings of the High Court of Justice at Madras recently, they made an application for the Court to rise at midday, an application which was granted because it was announced that a lunar eclipse was to occur at 10.30 P.M. upon the same day. It is difficult to say whether the advocates feared to lose their cases, or whether they hesitated to shock the sentiments of their clients. The fact remains that the Court did rise upon their application."

On looking over some examination papers the other day I came across the following curiously distorted essay. It is unlike the usual run of examination curiosities, in having the facts so nearly correct; and indeed it forms part of a very good set of answers:—

A total Solar Eclipe is caused by the shadow of the Moon's surface upon the Earth when it passes between us and the Sun.

As the Moon is at some distance from the Earth and much smaller, its shadow forms a very narrow belt of about 160 miles in width.

The Moon takes about 7½ minutes to traverse the Sun's disc, the time being shorter than this if it were not for the rotation of the Earth in the opposite direction.

The shadow belt traverses the Earth near the region of the Equator so it is possible to have it viewed it at different stages, and at times a little later.

Just before the Ecypes all becomes darker and the reflected sunglight thrgh the trees is crescent shaped instead of circular. Animals go home to roost and there is a wierd feeling in the air.

The Eclipe is immediately proceeded by a huge shadow hurrying through the air (It is not certain what this may be).

Then when the Eclipse is total there is sudden apparent darkness, which however we soon find to be lighter than moonlight, it is light enough to tell the time by.

This light is given by the Corona the halo immediately round the Sun.

It is very beautiful and brigtest at the part nearest the Sun.

We soon see the edge of the Su again appearing and the Moon's shadow is quickly gone.

Photography has been of great avail in photographin Total Eciples.

Mr. Q. has just written a new book with a very short title:—"Ia," by Q. Ia is a charming and unconventional fisher-girl, who s deeply smitten with a young minister, and by an artful stratagem carries him off in a boat, at midnight in February, to tell him so. The young man is naturally somewhat upset (not literally), and his feelings are described as follows:—"When he glanced up he saw the dew and moonlight mingling in her dark hair; saw the starshine in her dark eyes. Around them the firmament blazed with constellations up to its coping. Due west upon the forestay Orion hung, with the Twins above, and Sirius sparkling on the brink of the sea to the southward. Due south, high over the land, Regulus led the eye up to the Great Bear swinging right overhead, Procyon on the weather-bow; Hydra a little before the beam; Arcturus almost astern—as Paul's gaze travelled round on the windward side it encountered these three famous constellations and all at about the same altitude; while low down in the north-east, white Vega peeped under the boom-end. Forward the dusky canvas now hid and now revealed Aldebaran and the Pleiades. Never had Paul seen stars so multitudinous or so resplendent. Never before had they seemed so alive to him. He could almost hear them breathe. And beneath it all the little boat raced westward." The author has obviously taken great pains to be accurate, and the only exception to be taken to this accurate description is the presence of the Moon, which is not usually conducive to seeing stars "multitudinous and resplendent."

In a bookseller's window the other day I saw, to my astonishment, a book labelled "Astronomy as a Fine Art." It flashed across my mind how the scheme for an international catalogue now going forward had nearly been wrecked (so it is rumoured) by the indignation of an eminent Professor of physiology, when he found his science classed as a "Useful Art," and I wondered vaguely whether this view of astronomy was a product of the same scheme. On entering the shop to investigate, however, I found that I had been misled by a latent *G*, hidden by the next book; and that the fine art was merely Gastronomy.

The "University Extension Journal" has reached its seventh number and bids fair to be a success. There is a deal of good miscellaneous reading in it. Price threepence, monthly. But it can inflict as cruel a disappointment as a sixpenny weekly. Take, for instance, an article headed "The Prodigal Sun." Should not any self-respecting article, with such a title, and written at the present time, mention *helium* at least once? As a matter of fact there is no scientific information of a solid useful kind in it at all: it's merely a string of philosophical reflections on our decadence —a sort of sigh for the good old times when the Earth was warm, indeed very like a wail. The drift of it seems to be that the Earth is getting cooler and so we are all getting slacker. "Ah! those primitive times!" it moans "In the beginning things were done at a white heat. . . . . Most questions were literally burning questions, all to be solved, as all were solved, by the light of Nature." And this is the way it winds up:—"Time alone fails us and is out of joint—further decadence!—to show on what a cheerless day the Sun, or such as is left of it, sets now and totters falteringly over the horizon on the morrow. We should naturally pass to consider the coming century; but its cold greyness chills us to the bone. Its fate is as obscure as Jude, sombre as a Russian novel, sudden as a problem play, cold as 'un anglais qui parle d'amour.' Let us leave it to its fate, the German Emperor, and the Nordau-weels."

WAS the notion of parallax familiar to St. James? The Rev. A. Carr in a text-book on St. James (Camb. Univ. Press) considers that the sentence in Ch. I. v. 17: *Παρ' ᾧ οὐκ ἔνι παραλλαγὴ ἢ τροπῆς ἀποσκίασμα* ("with Whom is no variableness neither shadow of turning") is an astronomical metaphor throughout, and that *παραλλαγή* means parallax. "It is true," he says, "that no instance is cited of such a use of *παραλλαγή* before the date of this epistle, but neither is there an instance of *παράλλαξις* used in this sense earlier than Proclus, who, c. A.D. 440, wrote a paraphrase on a work of the astronomer Ptolemy (fl. A.D. 139), and the Modern Greek term for *parallax* appears to be *παραλλαγή*, not *παράλλαξις*. See Sophocles, Modern Greek Lexicon *sub voc.* This may represent a very ancient usage. . . . . The parallax of the Sun was calculated, though erroneously, by Aristarchus c. 250 B.C., and Hipparchus 162–127 B.C., a calculation adopted by Ptolemy and adhered to for twelve centuries. . . . . . The thought therefore would be familiar in St. James' time. Moreover he was writing to men living in regions where astronomy had flourished from a remote antiquity." Mr. Carr works hard to make out a good case. The *τροπῆς ἀποσκίασμα* is to be either (1) the shadow of night, or (2) the shadow of eclipse. In remarking that eclipses occur to other planets beside our own, the author quotes Newcomb's 'Popular Astronomy' on Jupiter's satellites. The quotation is inexact, but one mistake is apparently due to the source and not to the reproduction, viz., that Satellite I. revolves in 18 hours instead of 1 day 18 hours. See p. 210 of N. P. A., editions both of 1878 and 1883.

THE OBSERVATORY,

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MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, June 12, 1896.

Dr. A. A. COMMON, F.R.S., *President*, in the Chair.

Secretaries: E. W. MAUNDER and
E. B. KNOBEL (*vice* Prof. TURNER).

Mr. Maunder read the Minutes of the previous Meeting, which were confirmed.

Mr. Maunder. Ninety presents have been received since the last Meeting of the Society. Of those calling for special notice I might mention a book by Mr. Orchard on the 'Astronomy of Milton's Paradise Lost,' presented by Mr. W. H. Wesley; six photographs of stellar spectra taken with the 6-inch prismatic camera at South Kensington; a series of photographs of the region round η Argûs, presented by Dr. Gill, and a star-chart of the Southern Heavens from Mr. H. C. Russell, Director of the Sydney Observatory.

A vote of thanks was accorded to the donors of these presents.

Mr. Maunder read extracts from a series of papers by *Mr. J. Gledhill* on Jupiter's belts, spots, and satellites.

The President. Mr. Gledhill has evidently been trying to make a record in the way of number of papers. He has sent in no fewer than eight, all very interesting. Mr. Crommelin has a paper on a similar subject, which I will ask him to tell us about.

Mr. Crommelin. This paper has been written to point out that possibly there happened on the evening of March 30 last an eclipse of Jupiter's second satellite by the shadow of the third. I had my attention called to this by a note in the Journal of the Astronomical Society of Wales by Mr. Jackson, of Stoke-on-Trent, who was observing on that night with a 5-inch reflector, and noticed a temporary obscuration of the second satellite at about $9^h\ 20^m$ P.M., the other satellites being unaffected. Calculation showed that the satellite was in heliocentric conjunction with the third at $9^h\ 28^m$ P.M. (after correcting for light-time), and an error of $2''\cdot 0$ in the difference of latitude of the satellites, as given by the Tables, would suffice to place II. partially in the penumbra of III., while an error of $3''\cdot 5$ would produce a total eclipse. Such errors were larger than they would expect, but perhaps not wholly inadmissible. Mr. Jackson noted that the satellite grew lighter again shortly afterwards (apparently "struggling through something"), but he omitted to note the time of this brightening.

Dr. Gill. I should like to call attention to the comparative paucity of observations of this kind which would help to define the plane of the orbits of the satellites. It is very much to be desired that some mathematical astronomer should devote himself to the theory of the movements of the satellites of Jupiter, which still remains very much undeveloped.

Dr. Spitta. The subject that Mr. Crommelin has brought forward is one of great personal interest to me. Many years ago I made a special research on the subject of Jupiter's satellites with reference to their albedo, and I asked observers to send me any notes they might make bearing on the subject. I did not receive a single note which showed that the second satellite was ever seen otherwise than bright, so I should think that this must be almost a unique observation which Mr. Crommelin has here recorded.

Dr. Downing. Referring to Dr. Gill's remarks, I may say that the theory of Jupiter's satellites has recently been lucidly evolved by M. Souillart. The difficulty does not lie in that direction, but it is the comparison of observations with the theory to determine the elements of the orbits which is the stupendous task, and one which demands considerable skill and discretion on the part of the computer. At the present time the plane of the orbits of the satellites passes nearly through the Earth, so that we may expect this kind of phenomenon now. The error of relative latitude in the case Mr. Crommelin refers to is only 2″, which is a quantity quite within the bounds of possibility.

Mr. Marth. In the diagram which was shown on the screen, it seemed to me that the umbra of the third satellite was too small.

Mr. Crommelin. I computed the diameter of the umbra and penumbra of satellite III. on a plane through satellite II., normal to the radius vector, and I think they are correct. Satellite II. was behind Jupiter, Satellite III. in front of the planet.

Mr. Marth. Then they moved in opposite directions; and if a central eclipse took place, the total eclipse would have lasted only a minute, and the whole of the partial eclipse only 6 minutes. It is a pity that Mr. Jackson did not note the time more accurately. If the diminution of light lasted more than a few minutes, then I think it is doubtful if it was an eclipse.

Mr. Crommelin. Mr. Jackson does not say anything about the duration, but gives the time of beginning of obscuration as $9^h 20^m$.

Mr. Marth. I think an error of 3″ of the tables is too much to assume. The observation does not decide anything, because the time is not given. I will take this opportunity to ask, as I have asked before, that observers should make accurate micrometer observations of the position of the shadow of the satellites as they cross the disc.

The President. One thing that tells in favour of the genuineness of this observation is that it was not predicted. There is an obvious difference in observing a predicted phenomenon and one that is made without premeditation. If it were not an eclipse it is remarkable that a defalcation of light should have been observed just when such a defalcation would have happened if we allow a slight error in latitude. If a thing is predicted, an observer is perhaps unconsciously biassed in a delicate observation of this kind; but in this case the occurrence seems to have been quite unexpected.

A vote of thanks was accorded to Mr. Gledhill and to Mr. Crommelin.

The President. The Society is honoured to-night by the presence of our illustrious colleague, Prof. Newcomb. If he can tell us something of the astronomical work going on in America, I am sure the meeting will feel favoured.

Prof. Newcomb. It would be ungracious to decline altogether the kind invitation you have given me to address the Meeting, but I have very little in my mind which would interest this audience. I have lately been in Paris, as representative of the American 'Nautical Almanac' at a conference of the Superintendents of the four leading Astronomical Ephemerides of the world, where we discussed the advisability of using a common system of star-places and constants in all these four works; and I may say we have agreed upon such a common system, which will come into use from and after the year 1901.

The President. I am sure we are very glad to welcome Prof. Newcomb at the Royal Astronomical Society. We are also glad to see Dr. Gill here, who is making one of his periodical visits to England; perhaps he will be good enough to tell us something of his work, past and future. I believe that owing to the munificence of Mr. McClean he is adding a new sphere of work to the programme of the Cape Observatory.

Dr. Gill. Our President has rather taken the words out of my mouth, especially as he asked me to say something about what I was going to do. I was going to say that in our southern hemisphere we have been singularly unfitted with regard to our astronomical instruments for physical research, but we are now going to try, with the assistance of Mr. McClean, to begin work of this kind. I do not think there is much interest in talking about what one is going to do. I hope next time when I come to England that

I shall be able to tell you what has been done with this fine instrument which is being made. My object lately has been to bring to a close what has occupied me hitherto. We have finished the photographs of the stars to the 10th magnitude, and they have been made into a Catalogue, the first volume of which is printed, the second is in the press, and the third is ready to be printed. The results of the geodetic operations which I initiated at the Cape have been communicated to the House of Assembly at Cape Town, and a book about that survey will be in the library of this Society shortly. I may say that the latitude arcs measured are so situated that they are not well adapted to afford any evidence about the figure of the Earth, but the longitude arcs point to the probability that Bessel's value for the ellipticity of the Earth is more in accordance with facts than Clarke's. The Cape Catalogue of stars for epoch 1885 has been published and that for 1890 is far advanced, so that we are clearing off our work of the class of astronomy proper, and getting ready for physical astronomy. I would like to add that at the recent astronomical conference it was voted that differential measures of planets made with a heliometer were more reliable than meridian observations; and I hope that the result of this will be that in the future we shall determine the places of the exterior planets with far more accuracy than in the past.

Mr. E. J. Stone made a suggestion to those persons who would observe the solar eclipse of August next without an instrument. A valuable work that such observers could do was to make accurate drawings of the corona as to the size and direction of the streamers, but it was known from experience that persons even of some skill as draughtsmen would make considerable differences in such drawings. The plan suggested was to have a paper prepared, ruled with concentric circles and with equidistant radii, on which one could plot down with some accuracy salient points of the phenomena as seen.

Mr. McCarthy. I am glad that Mr. Stone has drawn attention to the expediency of recording the appearance of the corona in another way than by photography. I hope that Mr. Green will be able to make drawings of it.

Mr. N. E. Green. I intend to go to Norway, and shall try to make as good drawings as the circumstances will permit me.

Dr. Johnstone Stoney, in presenting his paper on the "Astrophysical Observatory of the Future," said that in two ways the equipment of an observatory might be improved—first, by doing away with the necessity for an equatorially mounted telescope and using instead some form of siderostat, and, secondly, by improving the means of support of large specula. The author described various forms of the siderostat—the ordinary form known as Foucault's, which was designed by S'Gravesande early in the eighteenth century; the polar siderostat, and its modifications; and the coelostat. The first-named form commended itself to

Dr. Stoney for many reasons, but it was at a disadvantage, because the rectilinear movement which was necessary to actuate the mirror did not always work with precision; but he proposed a plan to overcome this which depended on the geometrical principle that if a circle rolled on the inner circumference of another circle of twice its diameter, any point on the circumference of the smaller circle moved along a straight line. A model of this movement was exhibited.

Dr. Johnstone Stoney also showed a model of a proposed new method of mounting large specula. The speculum was to be supported on the upper casing of a shallow air-chamber, the pressure of the air in which would be regulated ultimately by the pressure of a weight attached to the cell carrying the speculum in such a way that the component of the weight which controlled the air-pressure was always equivalent to the normal pressure of the speculum on the air-chamber.

The President expressed an opinion that Dr. Johnstone Stoney had overrated the difficulty of supporting the large mirror of a telescope, and explained technically his own method of supporting mirrors and also of polishing specula.

Mr. Thackeray showed the diagram in illustration of his paper on the "Corrections to R.A. of Stars derived from Observations of the Sun at Greenwich, 1835–95."

Dr. Gill made some remarks on his series of photographs of the region round η Argûs.

The following papers were announced and partly read:—

J. Gledhill. "Observations of the Phenomena of Jupiter's Satellites at Mr. Crossley's Observatory, 1895–96."

J. Gledhill. Seven papers on Jupiter's Belts, Spots, Satellites, &c.

R. H. M. Bosanquet. "Third Note on Precession and Drift."

A. W. Roberts. "Note on the Period of T Centauri."

Superintendent of the 'Nautical Almanac.' "Occultation of Stars in Præsepe, 1896 Oct. 1, visible at Greenwich."

G. Johnstone Stoney. "On the Equipment of the Astro-physical Observatory of the Future."

Alice Everett. "Galactic Longitude and Latitude of the Poles of Binary-Star Orbits."

Royal Observatory, Greenwich. "Observations of Comet *b* 1896 (Swift)."

A. C. D. Crommelin. "Note on a Possible Eclipse of Jupiter's Second Satellite by the Shadow of the Third, 1896 March 30."

W. G. Thackeray. "Corrections to the Right Ascensions of Stars derived from Observations of the Sun at Greenwich, 1835–95."

W. W. Bryant. "On the Proper Motion of B.D. $+25^\circ$ No. 2874."

W. E. Plummer. "Cometary Observations at Liverpool Observatory, 1895."

E. J. Stone. "An Answer to Certain Questions asked in the 'Bulletin Astronomique' (tome xiii. mai 1896) on Time Measurement."

E. J. Stone. "The Observation of a Solar Eclipse without Instrumental Means."

The following gentlemen were elected Fellows of the Society:—

Rev. Frederick Lisle Bullen, Littleton Rectory, Thornbury, Gloucestershire; *Ernest W. Ellerbeck,* The Observatory, Scarborough.

The following Candidates were proposed for election as Fellows of the Society:—

George Alex. Sime Atkinson, 238 Newport Road, Cardiff (proposed by H. W. Lloyd Tanner).

John Burt Trivett, Trigonometrical Survey of New South Wales, Lands Department, Sydney (proposed by Joseph Brooks).

THE BRITISH ASTRONOMICAL ASSOCIATION.

The seventh meeting of the sixth session of the Association was held on Wednesday, May 27, at University College, Gower Street, the President, *Mr. E. Walter Maunder,* occupying the Chair.

Nine new members were elected, and the names of 7 candidates for membership were read and suspended.

Papers on "Observations of Saturn" and "The Appearance of Saturn," by *Herr Leo Brenner* and *Mr. Roberts* respectively, were read by the *Secretary.* Herr Brenner pointed out that Herr Fauth's observations of changes in the appearance of Saturn's rings entirely confirmed Mr. Roberts's observations read at a previous meeting. Mr. Roberts also referred to a paper in the 'Bulletin of the Société Astronomique de France' for May, by M. Antoniadi, as confirmatory of his observations.

Capt. Noble said that he had read the paper in question and thought that as Herr Brenner's observations were confirmed by Mr. Roberts and others they could not do otherwise than accept them.

The President remarked that these changes in the delicate markings of Saturn's rings were just what from theoretical considerations might be expected, as they were not looking upon a solid continuous body but on a swarm of discrete particles moving in more or less independent orbits.

Dr. Downing at the invitation of the President gave an account of the recent Astronomical Conference at Paris. The Conference had been called for the purpose of adopting a uniform catalogue of standard stars for use in the different astronomical ephemerides for France, America, Germany, and England. It was obviously important that the stars in these ephemerides should be reduced to the same system, more especially in the case of the right ascensions. But the adoption of this fundamental catalogue of stars involved also the adoption of a uniform system of certain of the astronomical constants which were used in the reduction, such, for instance, as the precession, nutation, and aberration. The Conference originally consisted of four directors of astronomical ephemerides representing France, Germany, America, and England, but was enlarged by allowing each director to nominate one colleague, Dr. Gill being the speaker's colleague. In addition to these, Prof. Bakhuyzen and M. Trepied acted as secretaries. The Conference was not satisfied with any existing investigation of the constant of precession, so that question was confided to Prof. Newcomb, the able and energetic director of the American 'Nautical Almanac.' The constant of nutation which they adopted was 9″·21, and the constant of aberration 20″·47. The value adopted of the solar parallax was 8″·80.

The social side of the Conference included a ball, a dinner, various dejeuners, and a visit to the opera. They also visited the Académie des Sciences and the Sorbonne, the most magnificent building devoted to educational purposes he had ever seen.

The President in thanking Dr. Downing for his interesting address alluded to the well-earned honour which had been awarded to their distinguished fellow member, Dr. Gill, in his being created a C.B. He also heartily congratulated Dr. Downing on his recent nomination to the Fellowship of the Royal Society.

Mr. Davis read a note describing what appeared to be an occultation of Jupiter's first satellite by the second on May 21st about $8^h\ 20^m$.

Mr. Crommelin referred to a paper by Mr. Jackson in the 'Journal of the Astronomical Society of Wales' describing what appeared to be an eclipse of Satellite II. by Satellite III. on March 30. Mr. Crommelin added that it would require a slight alteration of the tables, about 2″ in the difference of latitude, to make this possible. He remarked that just now the orbits of the satellites of Jupiter were presented to us nearly edgewise, so that a number of occultations and mutual eclipses were possible.

Mr. S. H. R. Salmon read some notes on Comet Swift, and several members joined in the discussion.

Lord Hampton inquired whether it was not a fact that the last great display of November meteors took place in 1866, not in 1864 as stated in the Journal; and if that were so, the next display would be in 1899 not 1897. The President said that was so, but it was very desirable that they should be carefully looked for every year from the present time.

A paper by *Mr. Roberts* on "An Observation of the Planet Uranus" was read. The paper was accompanied by two drawings, showing the belts, made with a 6½-in. telescope.

Papers by *Herr Leo Brenner* on the "Visibility of the Dark Side of Mercury" and by *Mr. C. J. Merfield* on a "Solar Phenomenon" were read.

The Meeting then adjourned.

ROYAL METEOROLOGICAL SOCIETY.

The last Meeting of this Society of the present session was held on Wednesday evening, the 17th inst., at the Institution of Civil Engineers, Westminster, *Mr. E. Mawley, F.R.H.S.*, President, in the Chair.

Mr. H. Harries read a paper on "Arctic Hail and Thunderstorms," in which he showed that the commonly accepted opinion that hail and thunderstorms are almost, if not quite, unknown in the Arctic regions is incorrect. He had examined 100 logs of vessels which had visited the Arctic regions, and found that out of that number no fewer than 73 showed that hail was experienced at some time or other. Thunderstorms were not so frequent as hail, but they have been observed in seven months out of the twelve, the month of greatest frequency being August. Mr. Harries is of opinion that the breeding-place of thunderstorms in these high latitudes is in the neighbourhood of Barents Sea.

A paper by *Mr. J. E. Cullum*, on the "Climatology of Valencia Island," was also read. The observatory at Valencia, which is under the control of the Meteorological Office, is situated on the extreme south-west coast of Ireland, and is nearly the most westerly point of Europe. Continuous records from self-recording instruments were carried on from 1869 until 1891, when the observatory was removed to Caherciveen, and the author gives the results of the observations for these 23 years.

The Astrographic Chart Conference.

The third meeting of the International Permanent Committee for making a Photographic Chart of the Heavens was held at Paris, 1896, May 11 to 15. There were present as representing the different countries:—*France*: Tisserand (President), Loewy, Cornu, Wolf, Paul Henry, Prosper Henry, Faye, Trepied (Secretary), Bouquet de la Grye, Gautier, Laussedat, Rayet, Baillaud, Perrotin, Stephan, Callandreau. *England*: Christie, Gill (Vice-President), Turner, Abney, Knobel, Common. *Germany*: Scheiner. *Russia*: Donner (Secretary), Backlund. *Italy*: Ricco, Laïs. *Spain*: Viniegra. *Holland*: Bakhuyzen (Vice-President). *Sweden*: Dunér. *Mexico*: Anguiano. *United States*: Jacoby. Prof. Newcomb and Dr. Downing were also present on the last day.

After the election of President and Officers as shown in the above list, reports on the state of the work were received from the different observatories. These showed that most of the cooperating institutions have practically completed their series of Catalogue plates, but Chili, Rio de Janeiro, and La Plata have done nothing on account of the political state of those countries, and that the Catania Observatory is not progressing for want of funds.

Discussion of a previously prepared programme of questions then followed, as result of which the following Resolutions were adopted, unanimously in all cases.

Catalogue Plates.

1. The Conference is of opinion that the probable error of the rectilinear coordinates measured on the plates should be reduced to the smallest possible limits, and that the method of measurement should be such that the probable error should never be above $0''\cdot20$.

2. (*a*) The Conference considers it desirable that the rectilinear coordinates of the stars should be published as soon as possible.

   (*b*) It is desirable that this publication should include the data necessary for converting the results into equatorial coordinates.

   (*c*) The Conference expresses the hope that a provisional catalogue of the Right Ascensions and Declinations will be published by those observatories which can command sufficient funds.

3. Each observatory will be free to select the positions of Fundamental Stars (*étoiles de repère*) from those catalogues that appear most suitable. It is agreed that for computing the constants of a plate a minimum of 10 Fundamental Stars if possible should be employed. The adopted positions of the Fundamental Stars are to be published.

4. The question of ascertaining the desirability of adopting at all observatories a uniform system of constants for reducing these stars to epoch 1900 will form the subject of future discussion.

5. The Conference recommends that a uniform size of publication be adopted by all observatories. This size to be that of the Catalogue of the Paris Observatory.

6. The observatories will be at liberty to determine the Photographic Magnitudes either by measurement or by estimation—the only condition which the Conference deems it necessary to impose is that the system of Photographic Magnitudes on which the measurements or estimations depend, shall be capable of precise definition in such a way that different scales of Photographic Magnitudes adopted at different observatories can be reduced to a common system.

Photographic Chart.

7. Each observatory shall be furnished with a scale of density which shall be photographed on the plates at the same time as

the réseau, and which shall allow of the determination of the sensitiveness of each plate for stars of different magnitudes.

Capt. Abney is requested by the Conference to undertake the preparation of the above scales.

8. For the construction of the Chart, the second series of plates, namely those of which the Declinations of the centres are odd numbers, shall be made with 3 exposures of 30 minutes each. This time of exposure will of course be reduced should photographic plates of greater sensitivness be produced.
9. The Conference accepts the method of photogravure on copper for the reproduction of the chart; to be made from the plates with triple exposure—enlarged twice.
10. The observatories shall make by contact two positives on glass, of which one shall be deposited with the Bureau International des Poids et Mésures at the Pavillon de Breteuil.

The following opinion was expressed by the Conference:—

The International Conference of 1896 desires to express the hope that sufficient funds may be given to the Observatory of Catania by the Italian government both for taking the photographs and for the necessary work of their measurement aud reduction.

An Earth-bending Experiment.

THE following is an account of an experiment made at Oxford on May 5 of the present year, at the instance of Prof. John Milne, F.R.S., which has an indirect but still definite bearing on astronomical observations.

Professor Milne has been working at seismology for many years in Japan, but has now returned to England, and has set up a horizontal pendulum in the Isle of Wight, to obtain a continuous automatic record of such disturbances as are there manifested. These disturbances are of various kinds: some are real local earthquakes though on a very small scale; others are faint echoes of more violent distant earthquakes; others, again, are disturbances due to meteorological causes, and it is to these last that Prof. Milne is at the present moment especially directing his attention, and it was for their elucidation that he requested the experiment below described. He has been led to consider the disturbances due to the falling of rain and dew, from the following point of view: a shower of rain or a fall of dew represents a considerable load on the soil, which may be perhaps regarded in the first instance as uniformly distributed, but which will probably not remain so owing to inequalities in evaporation. The ground to the south side of a building, for instance, will be dried more quickly than that to the north; the dew on the east side will evaporate before that on the west side, and so on. Thus there will be bending stresses in the soil tending to tilt any buildings or piers for instruments which have not deep laid foundations. Such tilts as are due to rainfall will be irregular, though with an annual period of some kind running through them: such as arise from dew should show a diurnal period. The main question is of course the *amount* of these tilts—whether, for instance, they are large enough to affect astronomical observations. Seismographs set up at different stations in Japan show a well-marked diurnal oscillation of several seconds of arc, and Prof. Milne is inclined to ascribe this oscillation to the fall and evaporation of dew. It is clear that if the pier of a transit-circle is liable to sway about to this extent during the day, owing to a well-known and persistent cause, then we must determine the means of correcting observations of level made at one time of day to another time at which we may wish to use them. It is unlikely that diurnal oscillations of several seconds of arc could exist in the case of a transit-circle without being soon detected; though it seems quite possible that if the magnitude does not exceed a few tenths it might evade detection unless special pains were taken. Several attempts have been made to discover a diurnal inequality in the level readings for the transit-circle at Greenwich; but although there have been periods when a diurnal variation seemed to recur for several days in succession, no sensible systematic and sustained inequality has hitherto been established. Still the circumstances may be in this particular case exceptionally favourable to stability; and we should not be the less alert in other cases. The evidence seems to be conflicting. Prof. Milne finds many instances of clear diurnal inequality and suggests a plausible *vera causa*: the fact that in some cases the diurnal inequality is insensible must not be allowed too much weight; while crucial experiments as to the effect of a disposable load in bending the soil are clearly of considerable interest.

Such an experiment in which the disposable load on the soil was a crowd of human beings was sketched by Professor Milne in the following terms:—"I think I should begin as follows. Take 100 people as a solid square and march them up to the observatory wall. If a level placed on the window-sill does not show any effect the experiment ends. If there is an effect it is noted as they approach and recede.. Next take the group opened out so that they can touch each other's finger-tips when they stretch out their arms. This will give each man a space of about 5 × 5 ft. After that, open out until they have 10 × 10 ft., which is the evaporation effect." The observatory referred to was the Oxford University Observatory, which stands alone in a flat grass park, and was considered especially suitable for the experiment. The pieces of apparatus required were thus a delicate level, and a crowd of 100 people willing to perform the manœuvres above indicated. As regards the former Prof. Milne brought his horizontal pendulum to Oxford and set it up, not on a window-sill, but on a slate slab (destined for the mounting of a small transit-circle, but at present vacant), on which was also placed, side by side with the horizontal pendulum, the level used with the Barclay transit-circle (1 div. = 1″·0). The pendulum was adjusted to be about 3 times as sensitive as the level, *i. e.* a motion of 3 mm. was equivalent to 1″·0. As regards the crowd, a letter was written to the 'Oxford Magazine' explaining the circumstances and asking for volunteers. In response, 76 people assembled at the appointed time—quite sufficient for the experiment; a solid square was formed and marched in close and then in open order to various positions; and the weight of it was found to produce an appreciable bending of the earth. The details are as follows:—

The crowd collected on May 5 at 12.15; 76 men in all. Four companies of 18 each (with commanders = 19) were formed by Mr. G. C. Bourne, arranged as a solid square in close order, and marched to a position with front rank 90 feet to the north of the slate slab (Position I.). They were then marched up to 10 feet from the slab, N. side (Position II.). Then retired to 90 feet (Position III.). Then brought up to 5 feet from the slab, counting always from front rank (Position IV.). Then retired to 90 feet (Position V.). Then brought up *in open order* of one arm's length (each man's outstretched arm could touch his four neighbours' bodies) to 5 feet from slab (Position VI.). Then away again (Position VII.). Then in *very open order* (each man's outstretched arm could touch the fingers of his neighbours' outstretched arms) and front rank still 5 feet from slab (Position VIII.). Then away again (Position IX.). Then in close order on the *south* side front rank 5 feet from slab (Position X.). Then retired (Position XI.).

It will be seen that the positions with even numbers denote occasions when the crowd was in proximity to the instruments, and those with odd numbers when it was distant from them. We should expect the readings in odd positions to be all the same, but as a matter of fact they were found to differ somewhat. It seems fair, however, to regard as the effect of the crowd in any "even" position the excess of the reading of the instrument at that time over the mean of the preceding and following "odd" positions; and this assumption has been adopted in the following table, Columns 5 to 7. In Column 1 is the Greenwich mean time of the observations, given in minutes after noon. Column 2 is

		Readings of		Effect of crowd.		
G.C.T.	Position.	H.P.	Level.	H.P.	Level.	Mean.
h. m.		d.	″	″	″	″
12 27–28	I.	49·5	16·0			
29–31	II.	50·5	15·7	+0·4	+0·3	+0·35
32–34	III.	49·0	15·9			
35–37	IV.	50·0	15·1	+0·5	+0·7	+0·60
38–40	V.	48·0	15·8			
41–43	VI.	48·0	15·4	+0·2	+0·3	+0·25
44–46	VII.	47·5	15·6			
47–48	VIII.	47·0	15·2	+0·1	0·0	+0·05
49–50	IX.	45·6	14·5			
54–55	X.	44·3	15·7	−0·4	−0·7	−0·55
56–57	XI.	45·5	15·5			

explained above. Columns 3 and 4 give the actual readings of the instruments, and Columns 5 to 7 the deduced effect in change of level, the positive sign denoting a depression on the north side. The depression thus noted though small is always towards the crowd, which was on the south side in Position X. only. It amounts to $0''\cdot5$ or more only when the crowd is in close order and close to the instrument. In such a case the effect of the load must have been far greater than any possible effect due to rain or dew, and it seems fair to conclude that on the particular soil forming the University Park we are not liable to much tilt due to the cause suggested. It will be interesting to see whether under these conditions a horizontal pendulum will indicate any diurnal change of level, and we hope at some future time to test this point. H. H. TURNER.

Selenographical Notes.

REINER, HERMANN, &c.—Though situated in a somewhat barren part of the Oceanus Procellarum, where Marius and Galileo are the only other conspicuous objects to break the monotony of the grey surface, this little ring-plain will be found a very interesting formation when observed under a low Sun. In the 'Ast. Register' (Sept. 1886), I gave a full description of it, and subsequently, in the 'Journal of the Liverpool Ast. Soc.' (Vol. v. plate i.), a drawing of the neighbourhood, showing most of the principal ridges and markings for some distance on every side of it.

The observations, however, on which this description and drawing are founded were made under a somewhat advanced stage of sunrise, and consequently did not include certain very remarkable features which are displayed when the meridian which passes through the east wall of Reiner is on the morning terminator. Such were the conditions of illumination at $9^h\ 40^m$ on February 25, this year. They afforded a beautiful picture of the extraordinary chain of enclosures and partial enclosures extending from Reiner to Hermann, and bordering the terminator at this phase. The most prominent object is the brilliant western border of Reiner itself with the shadow of the giant peak upon it, nearly 10,000 feet high, masking a large portion of the opposite wall. This western border displays a peculiarity, occasionally found elsewhere, which is hard to account for by the once popular hypothesis of the origin of lunar ring-mountains. Its lower portion is prolonged in the form of a bright and slightly curved wall of considerable height to a distance of at least 45 miles towards the south, when it gradually diminishes in altitude, and forms the western rampart of the first link of the chain of the enclosures (*a*) just mentioned. This wall, to all appearance, is a constituent part of the ring-plain Reiner, and contemporary with it. There are indications, marked by fragments of a ridge on the east, that a section of it represents the western half of a degraded enclosure which once adjoined the southern side of the ring-plain, but, however this may be, there can be no doubt as to the true character of the object (*a*) at its southern end. Here we have a formation somewhat larger than Reiner, with complete but very low ramparts on the east and west, that on the west consisting of an extension of the W. wall of ring-plain. On the north it has been entirely wrecked, only four or five bright little hills remaining to represent the site; while on the south the gap is complete, and is flanked by two small but very brilliant crater-cones, easily traceable under a high light, which doubtless once formed part of the original barrier. Immediately south of this lies a second obscure enclosure (*b*), formed by parallel ridges, about half the width of the last, but nearly twice as long. At the south-west corner of this stands a third brilliant little crater-cone, also visible under a high Sun, and, close to it on the south, a fourth very similar in size and brightness. This is situated on the north-western side of the third enclosure (*c*), which is circular in form (though of course considerably foreshortened) and tolerably complete, the widest gap being on the north. On the south its continuity is broken by a crater some 3 miles in diameter on the north-west of Hermann.

If these obscure rings are examined under the conditions just described, it is clear that they are not due to a fortuitous arrangement of ridges, but represent the relics of formations that have been subjected to some destructive influence, whose effects are traceable in almost every part of the southern section of the Oceanus Procellarum and on the adjoining Mare Nubium, as I have pointed out in a paper recently published in the 'Journal of the Brit. Ast. Association.'

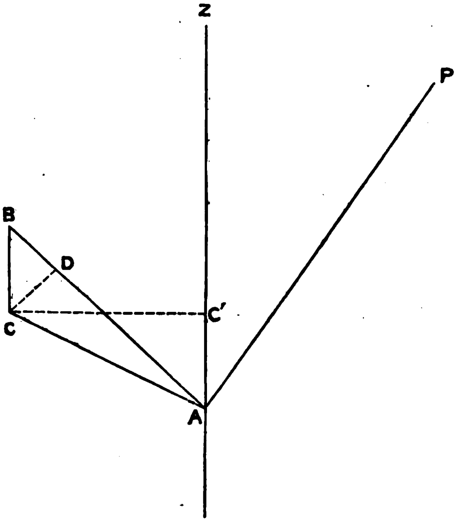
The bright crater immediately north of Hermann appears to be drawn too small in Schmidt's map. It is at least one half the diameter of its neighbour. On the west of the pair and separated from them by a straight ridge is a dusky area semicircular in shape, its diameter being about 30 miles, bounded by a low bank. A craterlet stands near its centre. Schmidt shows two conspicuous craters on the plain north of Reiner. I find a third close under the north-east wall with a little mountain very near to it on the north-east. With the exception of these objects, this region is curiously devoid of craters.

Beaumont House, Shakespeare Road,
Bedford, 1896, June 19.

T. GWYN ELGER.

A Formula to correct Double-Star Observations for Refraction.

REFRACTION raises the images of both components of a double star on the altitude circles, which amounts to the same thing as saying that the companion is raised when it is lower than the main star and lowered when it is higher than the main star, so that the correction to the observed distance is always positive. The zenith distance, z, and the parallactic angle, p, are calculated in the first instance or read off on a globe. The rate of increase (k) of refraction per second increase of zenith distance is then taken from a suitably constructed table of mean refractions. No account need be taken of pressure and temperature. Z is the zenith, P the pole, A the main star, B the companion, C the companion apparently lowered by refraction, AB the true distance $=\rho$, AC the observed distance $=\rho'$, PAZ $=p$, PAB $=\theta$ the true position-angle, PAC $=\theta'$ the observed angle, BAC $=\theta-\theta'$ the correction for refraction in angle, BA$-$CA $=\rho-\rho'$ the correction for refraction in distance, ABC $=$ BAZ $=\theta-p$. Neglecting quantities of the second order, we have, if from C we draw a perpendicular upon AZ cutting AZ in C′:



$$\mathrm{BC}=k\times\mathrm{AC'}=k\rho'\cos(\theta'-p),$$

$$\sin(\theta'-\theta)=\mathrm{BC}\sin\mathrm{ABC}/\rho'=\tfrac{1}{2}k\sin 2(\theta'-p),$$

$$\theta=\theta'-\frac{k}{7200}\sin 2(\theta'-p)=\theta'+\mathrm{T};$$

and if we draw from C a perpendicular upon AB cutting AB in D, we have:

$$\mathrm{AB}=\mathrm{AD}+\mathrm{BD}=\rho'+\mathrm{BC}\cos(\theta'-p),$$

$$\rho=\rho'+k\rho'\cos^2(\theta'-p)=\rho'\mathrm{R}.$$

The following table shows the value of R, with arguments z and $\theta - p$:—

R.

$\theta - p$.		$z = 72\frac{1}{2}^{\circ}$.	75°.	$77\frac{1}{2}^{\circ}$.	80°.	$82\frac{1}{2}^{\circ}$.	85°.	$\theta - p$.	
360°	0°	1·0030	1·0040	1·0057	1·0083	1·0140	1·0277	180°	180°
350	10	·0029	·0039	·0055	·0081	·0136	·0269	170	190
340	20	·0026	·0035	·0050	·0073	·0124	·0245	160	200
330	30	·0023	·0030	·0043	·0062	·0105	·0208	150	210
320	40	·0018	·0023	·0033	·0049	·0082	·0163	140	220
310	50	·0012	·0017	·0024	·0034	·0058	·0114	130	230
300	60	·0007	·0010	·0014	·0021	·0035	·0069	120	240
290	70	·0004	·0005	·0007	·0010	·0016	·0032	110	250
280	80	·0001	·0001	·0002	·0003	·0004	·0008	100	260
270	90	·0000	·0000	·0000	·0000	·0000	·0000	90	270

The following table shows the value of T with the same arguments. When $0^{\circ} < \theta - p < 90^{\circ}$, or when $180^{\circ} < \theta - p < 270^{\circ}$, T is —; but when $90^{\circ} < \theta - p < 180^{\circ}$, or when $270^{\circ} < \theta - p < 360^{\circ}$, T is +.

T.

$\theta - p$.		$z = 72\frac{1}{2}^{\circ}$.	75°.	$77\frac{1}{2}^{\circ}$.	80°.	$82\frac{1}{2}^{\circ}$.	85°.	$\theta - p$.	
360°	0°	0°·00	0°·00	0°·00	0°·00	0°·00	0°·00	180°	180°
350	10	·03	·04	·05	·08	·14	·27	170	190
340	20	·06	·07	·10	·15	·26	·51	160	200
330	30	·08	·10	·14	·21	·35	·68	150	210
320	40	·09	·11	·16	·24	·39	·78	140	220
310	50	·09	·11	·16	·24	·39	·78	130	230
300	60	·08	·10	·14	·21	·35	·68	120	240
290	70	·06	·07	·10	·15	·26	·51	110	250
280	80	·03	·04	·05	·08	·14	·27	100	260
270	90	·00	·00	·00	·00	·00	·00	90	270

On December 4 last year I observed a double star, for which $z = 81^{\circ}{\cdot}5$, $p = -19^{\circ}{\cdot}6$, $\theta' = 237^{\circ}{\cdot}9$, and $\rho' = 6''{\cdot}62$. From the accurate formula I obtain $-0^{\circ}{\cdot}17$ and $+0''{\cdot}0048$ as the refraction corrections, and from the tables above $-0^{\circ}{\cdot}14$ and $+0''{\cdot}0040$. On December 16 I observed another star, for which $z = 75^{\circ}{\cdot}2$, $p = +17^{\circ}{\cdot}2$, $\theta' = 244^{\circ}{\cdot}7$, and $\rho' = 46''{\cdot}69$. The corrections were found $= -0^{\circ}{\cdot}086$ and $+0''{\cdot}092$, and from the tables above $= -0^{\circ}{\cdot}11$ and $+0''{\cdot}089$. This is accurate enough for double-star measures. W. Doberck.

Hong Kong Observatory, 1896, Apr. 26.

The Rings of Saturn, 1895 *and* 1896.

During the last few months slight differences in the appearance of the rings of Saturn were observed which seem to me to be worth recording. The instrument used was a 5-inch refractor by Wray; the eyepieces used were single lenses of magnifying-powers 135 and 180 diameters; negative eyepieces of 150 and 190, and also a positive eyepiece of 156 diameters. Only those observations when the images were perfect, or nearly so, are here recorded. The rings are distinguished by their usual designation, *i. e.* A, B, and C.

Beginning with A, the outer ring:—

This ring presented several peculiarities. In 1895 Dec. 21 at 20 hrs. G.M.T., the brightest part was a very narrow strip ⅓ of the breadth of the ring from the Cassini division, having a fine shading next it, making the division apparently the usual width. This bright portion, together with its shading, appeared to make up half the width of A; the remaining exterior half was considerably fainter but uniform in tint, having the extreme outer edge well defined though rather faint. During 1896 April 1, 12, 14, 17, the brightest portion was a rather broad strip (nearly half the breadth of A) situated just outside the centre of the ring and extending nearly to the outer edge, where a slight falling off in light was noticed, though the outer edge was well defined. The inner half was much fainter; indeed on April 17 it was difficult to see the outer edge of the Cassini division, thus giving an apparent greater breadth to the division than usual.

On May 3 and May 5 the inner half of the ring was uniformly the brighter part, whilst the outer was faint and uniform; on May 4, however, *it was exactly the reverse*—the inner half was the fainter and the outer the brighter. This was from 10 hrs. to 11½ hrs. On May 7 the appearance was the same as on May 3 and 5; on May 9 exactly the same as on December 21. On several nights at the end of May the Cassini division had the appearance as described for April 17; unfortunately I did not make particular notes at the time, as my attention was wholly taken up in observing spot-transits on Saturn.

No actual division was observed on this ring, though last year a fine but faint line was seen on a few nights.

Ring B:—

This ring was very uniform throughout, the outer part being the brightest, then gradually fading off to the inner edge. On May 3 a narrow fine division was seen somewhat nearer to the outer edge than to the inner, but not much; it was again seen on May 5, in the same place; at the *f.* end the division extended nearer the ball. On May 9 the fainter shading was distinctly stopped at the position of the division, though the latter was invisible.

Ring C was always well seen across the ball, having a dull orange colour. This ring is sometimes very difficult to see in good definition, *i. e.* when the state of the air is favourable for a good view:

this was the case on April 17, when only the inner edge was seen very distinctly, but no trace of the ring was visible near the ring B; this was observed on several nights. I am inclined to regard this, however, as owing to the comparative bright inner edge of B masking the very faint light of C, and this causing a visible separation between the rings. On May 3, C was seen touching B. All my observations seem to show that the inner edge of C is the brightest part and that it is uniform in outline.

In 1895 April 28, fine image, a dark division was visible in the middle of this ring at both ansæ with a power of 190.

Glasgow, 1896, June 10. HENRY MACEWEN.

[The apparent widening of the Cassini division has sometimes been noticed at Greenwich. It was especially marked on June 1 of this present year.—EDS.]

Total Eclipse of the Sun, 1893 *April* 16 *.

THE memoir first gives reports by Mr. Fowler and Mr. Shackleton as to the circumstances under which photographs of the spectra of the eclipsed Sun were taken with prismatic cameras in West Africa and Brazil respectively on, 1893 April 16. These are followed by a detailed description of the phenomena recorded, and a discussion of the method employed in dealing with the photographs. The coronal spectrum and the question of its possible variation, and the wave-lengths of the lines recorded in the spectra of the chromosphere and prominences, are next studied.

Finally, the loci of absorption in the Sun's atmosphere are considered.

The inquiry into the chemical origins of the chromospheric and prominence lines is reserved for a subsequent memoir.

The general conclusions which have been arrived at are as follows:—

(1) With the prismatic camera, photographs may be obtained with short exposures, so that the phenomena can be recorded at short intervals during the eclipse.

(2) The most intense images of the prominences are produced by the H and K radiations of calcium. Those depicted by the rays of hydrogen and helium are less intense, and do not reach to so great a height.

(3) The forms of the prominences photographed in monochromatic light (H and K), during the eclipse of 1893, do not

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* From Ast. Nach. No. 3359. Abstract of a communication to the Royal Society.

differ sensibly from those photographed at the same time with the coronagraph.

(4) The undoubted spectrum of the corona in 1893 consisted of eight rings, including that due to 1474 K. The evidence that these belong to the corona is absolutely conclusive. It is probable that they are only represented by feeble lines in the Fraunhofer spectrum, if present at all.

(5) All the coronal rings recorded were most intense in the brightest coronal regions, near the Sun's equator, as depicted by the coronagraph.

(6) The strongest coronal line, 1474 K, is not represented in the spectrum of the chromosphere and prominences, while H and K do not appear in the spectrum of the corona, although they are the most intense radiations in the prominences.

(7) A comparison of the results with those obtained in previous eclipses confirms the idea that 1474 K is brighter at the maximum than at the minimum sun-spot period.

(8) Hydrogen rings were not photographed in the coronal spectrum of 1893.

(9) D_3 was absent from the coronal spectrum of 1893, and reasons are given which suggest that its recorded appearance in 1882 was simply a photographic effect due to the unequal sensitiveness of the isochromatic plate employed.

(10) There is distinct evidence of periodic changes of the continuous spectrum of the corona.

(11) Many lines hitherto unrecorded in the chromosphere and prominences were photographed by the prismatic cameras.

(12) The preliminary investigation of the chemical origins of the chromosphere and prominence lines enables us to state generally that the chief lines are due to calcium, hydrogen, helium, strontium, iron, magnesium, manganese, barium, chromium, and aluminium. None of the lines appear to be due to nickel, cobalt, cadmium, tin, zinc, silicon, or carbon.

(13) The spectra of the chromosphere and prominences become more complex as the photosphere is approached.

(14) In passing from the chromosphere to the prominences, some lines become relatively brighter but others dimmer. The same line sometimes behaves differently in this respect in different prominences.

(15) The prominences must be fed from the outer parts of the solar atmosphere, since their spectra show lines which are absent from the spectrum of the chromosphere.

(16) The absence of the Fraunhofer lines from the integrated spectra of the solar surroundings and uneclipsed photosphere shortly after totality need not necessarily imply the existence of a reversing layer.

(17) The spectrum of the base of the Sun's atmosphere, as recorded by the prismatic camera, contains only a small number of

lines as compared with the Fraunhofer spectrum. Some of the strongest bright lines in the spectrum of the chromosphere are not represented by dark lines in the Fraunhofer spectrum, and some of the most intense Frounhofer lines were not seen bright in the spectrum of the chromosphere. The so-called "reversing layer" is therefore incompetent to produce the Fraunhofer spectrum by its absorption.

(18) Some of the Fraunhofer lines are produced by absorption taking place in the chromosphere, while others are produced by absorption at higher levels.

(19) The eclipse work strengthens the view that chemical substances are dissociated at solar temperatures.

J. NORMAN LOCKYER.

London, 1896, April 17.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Early Observations of the Zodiacal Light.

GENTLEMEN,—

Arago, in his 'Astronomie Populaire,' quotes from Mairan a passage in the ecclesiastical history of Nicephorus, which has been thought to be the earliest record of an observation of the zodiacal light. It gives an account of a remarkable appearance in the sky seen for a considerable time in the summer and autumn of A.D. 410, the year in which Rome was taken by Alaric. Nicephorus takes credit to himself for concluding that not having a stellar nucleus, it could not have been a comet, as many ignorant persons thought.

It may be of interest to refer to an account of a very similar appearance stated by Diodorus Siculus to have been seen nearly eight hundred years before the above time and said to presage an end to the hegemony of the Lacedæmonians, it being in B.C. 373, two years before the battle of Leuctra, which was fought B.C. 371. The passage will be found in lib. xv. c. 50 of his 'Bibliotheca' and runs thus :—

"Ὤφθη μὲν γὰρ κατὰ τὸν οὐρανὸν ἐπὶ πολλὰς νύκτας λαμπὰς μεγάλη καιομένη, ἀπὸ τοῦ σχήματος ὀνομασθεῖσα πυρίνη δοκίς."

This is quoted in the 'Mémoires de l'Académie Royale des Sciences' for 1702, p. 108, where it is translated "On vit dans le ciel une grande lumière allumée pendant plusieurs nuits. A cause de sa figure on l'appella Poutre ardente."

Cassini, having noticed a phenomenon of the same kind at the beginning of March 1668, and his nephew Maraldi a similar one at Rome on the 2nd of March, 1702, just thirty-four years afterwards, calculated that B.C. 373 was 60 times 34, or 2040 years before A.D. 1668, and therefore suggested that the appearance recurred regularly at that interval. Aristotle thought, he says, that it was the tail of a comet of which the head was not visible. We know now that such really was the case with the appearance observed by Cassini in 1668, for the head was seen in the East Indies and at the Cape of Good Hope. But he hesitated to take that view and suggested as a cause a motion in the poles of the Sun. It would appear that he did not think the appearance noticed by Maraldi in 1702 was of the same nature as that observed and described by himself in 1683 (had he done so there would have been an end of his theory of a thirty-four years' period), which he calls "la lumière répanduë sur le Zodiaque," an expression afterwards shortened into the "Zodiacal Light."

The first person, I believe, who gave what is undoubtedly a real description of the Zodiacal Light was Joshua Childrey, in a small book published in 1660, under the somewhat fanciful title of 'Britannica Baconica.' This gives a very brief sketch of the natural history of England and Wales under the different counties, and a still shorter of that of Scotland. The whole consists of no more than 184 pages, and in the last two, after describing (which also he seems to have been the first to notice) the black space in the Milky Way between Cygnus and Cepheus, which has been compared to the so-called coal-sack near the Southern Cross, he writes thus:—

"In *February* and for a little time before, and a little after, that month (as I have observed several years together), when the Twilight hath almost deserted the *Horizon*, you shal see a plainly discernable way of the Twilight striking up toward the *Pleiades* or seven Starrs, and seeming almost to touch them. It is to be observed any clear night, but it is best *illuc nocte*. There is no such way to be observed at any other time of the year (that I can perceive) nor any other way at that time to be perceived darting up elsewhere. And I believe it hath been and will be constantly visible at that time of the year. But what the cause of it in nature should be, I cannot yet imagine, but leave it to further enquiry."

No mention, it may be remarked, is made of these observations of the black spot near Cygnus or of the Zodiacal Light, or of the black spot near Cygnus referred to above, in the account of Childrey, contained in the tenth volume of the 'Dictionary of National Biography.' And I cannot but express my regret that both in the title of his book and in quotations generally, the translators of Arago's 'Astronomie Populaire' have retranslated from the French instead of referring to the original English.

Yours faithfully,
W. T. LYNN.

Blackheath, 1896, June 3.

Note on the Table of Measures of Saturn's Ring.

Gentlemen,—

I have been interested in the table of measures of the Saturnian system given in the 'Observatory' for May 1896. This is a very valuable collection and the editors of the 'Observatory' have done an excellent piece of work in making it.

In rearranging my measures of Saturn for permanent use I found that, through the misplacement of a decimal point, a slight error has been introduced in my measure of the diameter of the outer ring as published in 'Monthly Notices,' vol. lvi., no. 4, where the diameter should have been 40″·132 instead of 40″·013.

This affects the mean result for the two years but slightly, but when the two sets of measures are tabulated independently, as in your valuable collection, it becomes noticeable. The value for this ring in the last line of your table should therefore be 40″·13 instead of 40″·01.

In casually glancing over your table there seem to be at least two misprints. The value of the outer diameter of the inner ring given by O. Struve in 1851 is printed 54″·15, evidently a misprint for 34″·15. Also the value of the outer diameter of the outer ring by Kaiser in 1856 is given as 29″·72, which doubtless should be 39″·72.

My attention has also been called to the error in my result for the diameter of the outer ring in the measures for 1895, by Mr. T. J. Moore.

Yours faithfully,
E. E. Barnard.

Superstition respecting Eclipses.

Gentlemen,—

I see in the Notes from an Oxford Note-Book in your number just received, an extract from the 'Daily Telegraph,' which appears to imply that the superstitions of the populace on the subject of eclipses are shared by the educated natives of India, such as the Vakeels of the High Court of Madras. That, however, is not a fair deduction from the facts: it would be just as legitimate to infer that the Members of the House of Commons are all devotees of racing because the House takes a holiday on Derby Day. The fact is that the pleaders, like their brethren in England, are not sorry for any excuse to take a holiday, and the occurrence of an eclipse is one of the recognized opportunities. Moreover, there are certain ceremonies to be observed which can only be neglected on pain of serious trouble. Some time before I left India, I was asked to give some relaxation from the usual hours of attendance on such an occasion, and on enquiring whether the applicant believed that his ceremonial observations would do any good, I was told that of course they would not and that no one of his people believed they would, but that the omission of these ceremonies would cause so much row in the family that they could not be avoided! And my friend was of a much less instructed class than pleaders.

Not only is this the case, but many years ago some very accurate data about an imminent eclipse were brought to my notice, which were said to be calculated by a celebrated Pundit, and, of course, were alleged to be the result of deductions from the rules of the Shastres: I found, on investigation, that the learned man had availed himself of the 'Nautical Almanac' for the year.

11 Clifton Gardens, Maida Hill, W.
1896, June 2.

Yours faithfully,
J. F. TENNANT.

OBSERVATORIES.

ROYAL OBSERVATORY, GREENWICH.—The annual visitation ceremony took place on June 6, when the Astronomer Royal presented his Report to the Board of Visitors, which was complete as to its number, excepting for the absence of Prof. Turner, who was already on his way to Japan to observe the Solar Eclipse. The following information taken from the different sections of the Report refers to the twelve months up to and including 1896 May 10.

Transit Circle.—The number of observations of transits made was 11,792; of zenith distance 11,463, which number includes 570 observations of reflexion stars and 636 determinations of nadir-point. The annual catalogue for 1895 contains 2653 stars. 29 sets of observations have been made with the personal equation machine for determination of personality in observations of limbs of the Sun or Moon, which are, however, not yet reduced.

The correction for R−D for the year is $+0''\cdot065+0''\cdot414 \sin$ Z.D., a value which is decidedly smaller than the result for recent years. An experimental attempt to determine the cause of this necessary correction has been made, with very little direct result, although some interesting evidence has been accumulated. The correction to the tabular obliquity of the ecliptic from solar observations in 1895 is $+0''\cdot05$. The correction to the right ascensions of the clock stars is $+0^{s}\cdot027$.

Altazimuth.—The total number of places of the Moon observed with this instrument was 64, or 5·0 per lunation. The new altazimuth lately constructed by Messrs. Troughton and Simms has been erected and will be ready for use shortly. This is virtually a reversible transit-circle of improved form, which may be placed in the meridian or in any azimuth, though it is only proposed to use it in certain definite azimuths.

Equatorials.—The 28-inch refractor has been in constant use for micrometric observations during the year. Measures have been made of 172 double stars, each star being measured on the average on two nights. Measures of the dimensions of Saturn's system were made on 9 nights and of Jupiter's diameter on 19 nights, both with the filar micrometer and with the double image. The weather during the opposition of Jupiter made it impossible for any systematic search to be made for Jupiter's fifth satellite.

The Astrographic Chart and Catalogue.—The number of successful plates added to the series for the chart during the year was 79, which brings the number taken up to 490. The number added to the Catalogue series is 223, making the total number 732. The number required for each series is 1149. The first measurement of these plates is nearly completed for all the stars between declination +65° and +68°. The number of stars measured during the year was 21,000, of which about 16,000 were measured on each of two plates. The formation of constants is effected for 121 plates.

The Heliographic section states that the spot activity has been steadily declining since the date of the last report, and gives details of the state of the reductions. The report of the meteorology of the past year speaks of the excessive heat of the month of September 1895. The greatest temperature of the year (87°·3) occurred on September 24, a temperature greatly exceeding all temperatures previously recorded at this advanced period of the year during the 54 years 1841–1894. The number of hours of bright sunshine in the month amounted to 194·8, giving a percentage of 52 on the possible amount. The mean temperature for the twelve months 1895 May to 1896 April was 50°·1, being 1°·7 above the 50 years average.

There have been several changes in the organization of the staff during the year. Besides the appointment of Mr. Cowell as second Chief Assistant, and Mr. Criswick's retirement with a consequent promotion, a new class of eight permanent officers, called Established Computers, has been made; the appointments to fill four of these have been made since the date of the report.

Paris.—M. Tisserand's Report for the year 1895, which he presented to the Council of the Observatory on March 6 last, opens with a short explanation of the necessity for a piece of work now in hand at Paris. This is the revision of the declinations of the fundamental stars on which the Paris Catalogue depends. These places were compiled in the first instance by Le Verrier on the basis of a comparison of Bessel's reduction of Bradley's observations with the Greenwich Catalogue of 1845, and have since been corrected in accordance with the Paris observations of the years 1868 to 1876. The places of the 'Connaissance des Temps' depend on this fundamental catalogue corrected by means of the Paris observations of 1856 to 1869, and a list of corrections deduced from the before-mentioned observations of 1868 to 1876 is given annually in the ephemeris. But it seems necessary that after twenty years the time has come to make re-observation of these star-places. The observations of Right Ascension for this purpose, which have been in hand during the last five years, are completed, and the discussion of these will be made shortly, and the observations of polar distance have been already begun with the Great Meridian Circle. The observation of the stars of Lalande's Catalogue has also been continued. Altogether, 17,567 meridian observations were made during the year.

With the Equatorial Coudé, MM. Loewy and Puiseux have continued to take photographs of the Moon for the purpose of making a large-scale map of our satellite. Photographs have been taken on 37 nights, but M. Loewy regrets that comparatively few of these can be considered as improvements on pictures already obtained. It is rare, he says, that one can get the three essentials—a clear sky, tranquillity of image, and a sufficient elevation of the Moon above the horizon—combined in one occasion. But experience has suggested some improvements in instrumental arrangements which may conduce to more numerous results in the future. Some of the plates already taken have been entrusted to a Paris firm to be copied by a heliogravure process, and a beautiful specimen of the Moon soon after first quarter is given as a frontispiece to the Report.

The other two Equatorials have been devoted to observations of comets and small planets.

As to the Astrographic Chart, 319 Catalogue plates have been taken, which brings the total number taken to 1155. The number of fields allotted to Paris is 1260. No Chart plates are reported as taken during the year. Eighty-eight plates have been measured by Mlle. Klumpke and her assistants, yielding in all about 37,000 stars, and 43 plates, containing 13,663 stars, have been reduced.

The Report contains also a section on the spectroscopic work of M. Deslandres, his researches on the rotation of Jupiter by Doppler's method and on the motion of Altair; and also refers to a labour of M. Bigourdan, who spent his holiday in determining the force of gravity on Mont Blanc at the cost of great exertion. He transported the pendulum apparatus, designed by Colonel Defforges, to *Grands-Mulets* and to Chamounix, where he made the necessary observations. In the forthcoming autumn he proposes to make similar observations on the summit of the mountain, if he finds it possible to reach there with the apparatus.

NATAL.—Two reports have recently been issued from the Natal Observatory, covering the period from 1894 July 1 to 1895 Dec. 31. The greater part of these pamphlets is taken up with the meteorological observations made at the Observatory and summaries of similar work at other stations in the colony. Little astronomical work has been done, owing to the absence of the Director and his wife (who fills the post of Senior Assistant) on six months' leave of absence, from March to October 1895. The staff consists only of two members besides these. The principal work in progress here is a comparison of the declination deduced from observations made at the observatories in the northern and southern hemispheres by a comparison by Talcott's method of the zenith distance of northern zenith stars and southern circumpolar stars at both upper and lower culminations. At the opposition of Mars in November 1894 it was proposed to make a series of observations, but cloudy weather prevented anything being done.

The Reports give some details about the time-ball apparatus, which seems to have been working rather unsatisfactorily.

The Time Signal formerly was sent at 1 o'clock Natal Observatory Time, but on 1895 Sept. 1 the official time of the Colony was altered to that of the 30th meridian East of Greenwich, so that the Signal is sent now at 1 o'clock Natal Uniform Time, which corresponds to $11^h\ 0^m\ 0^s$ Greenwich Mean Time and to $12^h\ 30^m\ 0^s$ Cape Colony Uniform Time.

BIDSTON OBSERVATORY, LIVERPOOL.—We have received a copy of the Report of the Director of this observatory for the year 1895. As this institution is under the control of a Board whose interests are navigational, the work done here is mainly meteorological and such as is connected with the testing of chronometers. But Mr. Plummer has not neglected astronomy altogether during the year: the Equatorial Refractor has been used for systematic observation of comets, and Comets Perrine and Brooks have been observed. Comet Faye was repeatedly looked for without success. Also, with the same instrument, a series of measures of diameters of the larger planets, with different micrometers and differently coloured fields, has been begun as experiments, which promises to be an interesting research. Besides the meteorological observations for the year and a summary for the same, the Report has an Appendix giving a catalogue of the gales of wind recorded at Liverpool from 1867–1895.

PUBLICATIONS.

MARS *.—Mr. Percival Lowell's book under this title has already been spoken of in another part of this magazine, but the receipt of a copy of the English edition from the publishers, in which they say certain alterations have been made, warrants us in mentioning it again, even at the risk of some repetition. The plan of the work, in which Mr. Lowell presents the results of a study of Mars during the last Opposition, is as follows:—The general astronomy of the planet is first described, then comes a chapter devoted to the Atmosphere, which is followed somewhat naturally by one on Water. This leads to Canals and Oases, and so to General Conclusions. The whole book is written in a most

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* 'Mars.' By Percival Lowell. (Longmans, Green, and Co., London.) 1896.

readable style, and bears evidence of much thought which has collated and sifted an enormous mass of promiscuous observational material gathered during the six months. We may say at once that we feel bound to accept these observations as sufficient evidence of the real existence of the markings without expressing an opinion as to what they may be; and having said this we do not propose to examine in detail, as Mr. Lowell suggests, the 917 drawings, sketches, and photographs made by himself and Messrs. W. H. Pickering and Douglass.

A good case for the existence of an atmosphere is made out, and we are glad that it is independent of his ingenious proof from micrometric measurements; for to those acquainted with the difficulties in the way of measuring the diameters of Mars it seems bold to deal so positively with 0″·1, which he claims to be the effect due to twilight. Of course the accuracy of the measures may be such as to warrant this confidence. The real interest of the book rests in the portion dealing with Seas and Canals. The general idea expressed is that Water is scarce on Mars, and that the Polar reservoir serves as the main supply. "Upon the melting of this polar cap, and the transference of the water thus annually set free to go its rounds, seem to depend all the seasonal phenomena on the surface of the planet." The flowing of this water from the Pole to the Equator, when more plentiful than at present, scooped out channels deviating westward. At present the descending stream is inadequate to make channels, so it flows in the old ones, and the low districts which were formerly seas thus receive a good share and become luxuriant with vegetation. This accounts for the dark colour assumed, and from which they have been thought to be real seas. But the scarcity of water makes irrigation the all-engrossing Martian pursuit, in fact "they must irrigate to live"—and from this remark it may be seen that Mr. Lowell postulates the existence of living beings. The artificial waterways constructed are of course too narrow to become visible, and we only see the result—the vegetation along their banks, the visibility being dependent on the season, the latitude, and the direction—canals running north and south becoming visible before those running east and west.

Such, in brief, denuded of all proofs and arguments, is the whole pleading, which cannot be properly grasped without reading the original and referring to the diagrams; and the original is worth reading—eminently so. Indeed, there is a subtle deftness in the way Mr. Lowell deals with his observations, which gives an impression that he has been there and seen it all, and it is really hard to say why we cannot accept his conclusions. It is probably because we are shy to receive new facts at a first statement. In time, no doubt we shall be as willing to accept his deductions (or facts) as the markings. We were about to advance reasons in objection, but they seemed poor; and really it is a case where each person must read and form his own ideas—but by all means read.

NOTES.

Comet Notes.—Swift's Comet was under observation at Greenwich up to June 6, but was then exceedingly faint. It may still be just visible with large instruments. The following ephemeris is for Berlin midnight:—

	R.A.	N. Dec.
	h m s	° ′
July 2....	20 25 29	68 25
6....	20 10 13	67 0
July 10....	19 56 59	65 25
14....	19 45 39	63 41

Brooks' periodic Comet (1889 V.) was discovered on its return by M. Javelle, at Nice, on June 20, being only 6′ distant from the predicted place. Mr. Chas. Lane Poor is to be congratulated on such an accurate prediction.

The comet is still very faint, but the brightness will increase considerably, perihelion passage being in November next.

The following is an ephemeris (for Greenwich midnight):—

	R.A.	S. Dec.
	h m s	° ′
July 3....	22 34 16	18 14
7....	22 36 8	18 11
11....	22 37 36	18 11
July 15....	22 38 37	18 12
19....	22 39 12	18 16
23....	22 39 20	18 19

Dr. John Riem has deduced the following definitive elements of the great comet 1881 III. (Tebbutt) (Nova Acta der Ksl. Leop.-Carol. Deutschen Akad. der Naturforscher, Band lxvi. No. 2):—

T = 1881 June 16·476941 Berlin M.T.

i	63° 25′ 24″	1881·0.
☊........	270 57 39	
ω	354 15 3	
q	0·7345443	
e	0·9959346	
Period	2429 years.	

He considers that the period is not more than 50 years in error. The elements strongly resemble those of the comet of 1807. Identity, however, is not possible. The two comets, however, may have had a common origin.

Prof. Holetschek is bringing out a work on the magnitude and brightness of comets and their tails. The first part, extending to the year 1760, has recently appeared, and a short abstract is given in Ast. Nach. 3359. Comets whose brightness (reduced to $r = 1$, $\Delta = 1$) is below the 6th magnitude seldom develop tails, and never conspicuous ones; while those whose reduced brightness exceeds the 4th magnitude generally develop conspicuous tails visible to the naked eye, especially if their perihelion distance be small.

A. C. D. C.

Minor Planet Notes.—There is an article by M. Gustave Ravené on the total mass of the group of minor planets in Ast. Nach. 3356. He assumes that the excess in the motion of the perihelion of Mars over its theoretical value (an excess amounting to 5″ per century) is due entirely to the perturbations of the minor planets; he then takes the following mean orbit for the group:—

$$\pi = 18^\circ\ 6'$$
$$\text{☊} = 150\ \ 0$$
$$i = 6\ \ 0$$
$$e = 0{\cdot}15$$
$$\log a = 0{\cdot}4315$$

He supposes the mass of the group arranged in a ring round this orbit, and hence deduces for this mass the value

$$\frac{\text{Sun's mass}}{37130000}.$$

This is about $\frac{1}{120}$ of the Earth's mass, or $\frac{2}{3}$ of that of the Moon. It is considerably larger than previous determinations based on assumptions regarding the density and albedo of the group.

Prof. Luther gives the following search ephemerides for the missing planet (132) Aethra, on two hypotheses of the mean daily motion:—

Assumed date of opposition.	R.A. on day of opposition.	S. Dec. on day of opposition.	Daily Motion.	
1896 June 18	$17^h\ 52^m$	17° 48′	-72^s	+8′
July 7	19 8	5 50	−66	+3

Ast. Nach. 3358 contains elements of planet CS by M. Charlois. The orbit resembles that of the missing planet (99) Dike, but the two planets are probably distinct. A. C. D. C.

The Period of the Earth's Rotation.—It is well known that observations of the Moon show inequalities of long period in the computed orbit that are not accounted for by the theory as at present set forth. A suggestion has been put forward from time to time that our adopted length of the mean solar day is incorrect. It is true that this suggestion also demands the assumption that the time of rotation of our Earth should be not uniform; but this is said to be not improbable, and dynamical reasons have been pointed out why this should be so. But apart from physical causes obviously the first step is to take some other standard with which we can compare the time-keeping qualities of the Earth, and the recurring phenomenon of Transits of Mercury was selected by Prof. Newcomb as such a standard some fourteen years ago. In a recent number of the 'Comptes Rendus' (1896, June 1) he takes up this subject again, now having at his disposal the observations of two more Transits, 1881 and 1894, and new tables of the planet's motion constructed by himself. Using these tables, the times of interior contact of Mercury with the Sun's disc have been computed on two hypotheses, A and B. In A it is assumed that the rotation of the Earth on its axis is uniform, and that our measure of time is correct. In hypothesis B the length of the mean solar day is taken so that it would account for the existence of the observed inequalities in the lunar theory. These calculated times have been compared with the observed times, and Prof. Newcomb points out that on hypothesis A although the differences are in most of the cases greater than the probable error of observation, still the differences have a systematic character which cause suspicion of an inequality in the rotation of the Earth. Taking means, the results of the differences, computed time − observed time, appear as follows:—

Of the six transits 1677 to 1769 ……	Mean	$-5^{\mathrm{s}}{\cdot}4$
Of the five transits 1789 to 1861 ……	„	$+6{\cdot}4$
Transit of 1868 ……….		$-1{\cdot}5$
Of the transits 1881 and 1894 ……..	Mean	$-3{\cdot}1$

With reference to these figures, Prof. Newcomb says "it seems that between 1796 and 1789 a slackening of rotation took place, and again another between 1840 and 1861. Towards 1862 this slackening is suddenly followed by a strongly marked acceleration which remained constant perhaps up to 1870. A remarkable thing is that this last conclusion is confirmed by the observed motion of the Moon, as I (Prof. Newcomb) mentioned some time ago."

Turning to the result from hypothesis B, the differences are still larger than the possible errors of observation, but if an empirical correction $-0^{\mathrm{s}}{\cdot}28\,(t-1838)$ to the mean motions of the planet be assumed, the observed times from 1769 to 1894 are well satisfied, but then the residuals for the eight transits from 1677 to 1743 are all positive, and their mean value is about 30 sec., which is quite inadmissible, so that Prof. Newcomb is forced to the conclusion that these long-period inequalities observed in the Moon's orbit are not explicable on this hypothesis, and suggests as another working hypothesis that they may be caused by the action of Venus, which is not accurately shown in the Lunar theory as computed by Hansen and Delaunay, because the terms of the second order produced by the mutual action of Venus and the Earth were neglected by these calculators.

THE VARIATION OF LATITUDE.—A recent research on the dynamical causes of the motion of the axis of rotation of the Earth is by Prof. Sloudiski, of Moscow (an abstract of his paper is given in 'Nature' of June 18). On the hypothesis that the Earth is a solid body with a cavity containing fluid, he deduces that the motion of the axis could be represented by two terms of periods respectively of about a year and about a day. As to the fact that the motion with this last-named period has not been detected by observation, he suggests that it may be too small to be recognized, or the circumstances of the astronomical observation may have masked this effect. For instance, if the period were exactly 12 sidereal hours, and the observations for latitude were always made about midnight, the effect would appear to have a period of a year.

THE OCCULTATION OF JUPITER ON JUNE 14.—A perfectly cloudless sky enabled the phenomenon to be well observed at Greenwich. The times of disappearance of the planet and of the four satellites were noted by several observers; the reappearance did not happen until the Moon had got down to the cloud-bank on the horizon. The time between first contact and total disappearance of the planet was about 49 seconds. One observer noted that Satellite III. took 3 seconds to disappear, but in most cases the disappearances of the satellites were noted as about of half-a-second duration.

HARVARD COLLEGE CIRCULAR, No. 7.—This latest announcement from Harvard gives a list of ten variable stars, whose variability has been recently discovered or confirmed by examination of photographic plates. Three of these had been previously suspected as variables by other observers.

A second section of this circular relates to photometric observations of the star S Antliæ, which has been regarded as a star of the Algol type, with a short period of $7^h\ 46^m \cdot 8$, and was said to retain its full brightness for less than half the time. The circular says in regard to this:—"One hundred and seventy-seven measures, each containing sixteen photometric settings on S Antliæ, were made with the meridian photometer, and give eight normal points. A smooth curve with only two points of inflection can be drawn through these normal points, the greatest deviation being 0·02 magnitudes. From this it appears that S Antliæ is not a star of the Algol type, and that its light is continually changing, and that it belongs to the class of variables of short period like δ Cephei and η Aquilæ. An interesting feature of this curve is that the time of increase occupies 0·62 of the entire time of variation, the increase of light being slower than the diminution."

FRAU WITTE'S MODEL OF THE MOON.—Our reference to the lunar model made by the mother of Maedler's wife has brought us information on the subject from several astronomers. Mr. W. H. Wesley points out that it is mentioned in the obituary notice of Maedler in 'Monthly Notices,' vol. xxxv. p. 173, that Frau Witte was an enthusiastic student of the Moon, and made a wax model of the lunar surface, which was sold to the King of Prussia, in which case it is scarcely likely to have formed part of the dowry. Prof. Schur, of Gottingen, tells us that Prof. Winnecke has in his possession a model of the Moon made by Frau Witte, whom he knew well. This model was exhibited at a loan exhibition at South Kensington in 1876. The extract from the catalogue, for which we are again indebted to Mr. Wesley, calls this a "Landscape of the Moon in relief," and says that after Frau Witte's death it was given to Prof. Winnecke by Frau Maedler. Dr. Dreyer also writes on the same subject, and adds some details about Maedler's early life which he (Dr. Dreyer) had from d'Arrest, who was a fellow townsman of Maedler. The great selenographer was brought up as a shoemaker, but, as he was a very skilful penman, became a writing master, when he fell in with Beer, a rich banker, brother to Meyerbeer the composer, with whom he collaborated in the well-known work on the Moon.

UNIVERSAL TIME.—In the report of the Natal Observatory given on p. 280, it will be noticed that a new Time System, based on the Greenwich meridian, has been adopted for general use in South Africa. It seems from this that the time now used in Natal is 2 hours and that used in Cape Colony is an hour and a half fast on Greenwich.

WE feel that we ought not to publish this number without some reference to the celebration at Glasgow, on June 15 and 16, of Lord Kelvin's jubilee as Professor of the University, although the occasion was scarcely astronomical, and the proceedings have been fully described elsewhere. Perhaps an extract from Lord Kelvin's speech, in which he pathetically illustrates once more the successes of *failure*, may form a fitting record of the event:—"One word characterises the most strenuous of the efforts for the advancement of science that I have made perseveringly during 55 years: that word is *failure*. I know no more of electric and magnetic force, nor of the relation between ether, electricity, and ponderable matter, nor of chemical affinity, than I knew and tried to teach my students of natural philosophy 50 years ago in my first session as professor. Something of sadness must come of failure; but in the pursuit of science inborn necessity to make the effort brings with it much of the *certaminis gaudia*, and saves the naturalist from being wholly miserable, perhaps even allows him to be fairly happy, in his daily work. And what splendid compensations for philosophical failures we have had in the admirable discoveries by observation and experiment on the properties of matter, and in the exquisitely beneficent applications of science to the use of mankind with which these fifty years have so abounded."

AMONG other celebrated men who were similarly honoured on the occasion of the Jubilee, Prof. Simon Newcomb was created LL.D. of Glasgow University. The University of Cambridge has since conferred on the American astronomer the honorary degree of Doctor of Science. The following is the speech made by the Public Orator on the occasion:—

"Si Thales ille Milesius, 'rerum naturae certissimus explorator et astrorum peritissimus contemplator,' sapiens propterea nominatus est, quod solem lunae oppositu solere deficere primus omnium vidisse fertur, etiam hunc virum sapientiae laude non indignum arbitramur, qui solis et lunae defectus omnes antiquitus observatos cum astronomiae legibus hodiernis accuratissime comparavit. Idem quanto ingenii acumine aliorum de lunae motu placita correxit; quam admirabili studiorum caelestium cognatione cum Neptuni inventore nostro consociatus est; quam infinita denique cura fratribus nostris transmarinis trans aequora navigantibus siderum cursus litterarum monumentis mandatos explicavit. Talium virorum de genere humano merita dum contemplamur, non iam miramur ipsum Vergilium a Musis esse precatum, ut sibi ante omnia

> 'caelique vias et sidera monstrent,
> defectus solis varios lunaeque labores.'

Duco ad vos astronomum illustrem, SIMONEM NEWCOMB."

THE DROUGHTS OF 1896.—The small rainfall which characterized the year 1895 has been followed and accentuated in 1896 by a succession of droughts of more or less pronounced character. The deficiency of rainfall in 1895 as compared with the average amounted to 4·8 inches, and in the six months January to June 1896 there is a further deficiency of nearly 4 inches. Indeed, had it not been for the somewhat copious rainfalls in March and in the earlier part of June the deficiency in supply would have been very marked. In May rain fell on 5 days only, amounting to 0·27 inch, in February on 6 days to the amount of 0·35 inch, and in April on 10 days to 0·56 inch. In 1895 the February rainfall amounted to 0·22 inch, that of May to 0·45 inch, and of June to 0·21 inch. But it may be noted that there has been a succession of dry years since 1883, the yearly rainfalls having been deficient as compared with the average in 10 out of the 13 years which have elapsed since then, the aggregate deficiency amounting to 24·29 inches, which is very nearly equivalent to the average yearly rainfall.

Smaller annual rainfalls than that experienced in 1895 have occurred in 8 years since 1841, notably in 1864, when the rainfall amounted to 16·38 inches, in 1847, when it was 17·61 inches, in 1858, when it was 17·70 inches, and in 1884, when it was 18·05 inches. The rainfall in 1895 was 19·72 inches.

We regret to announce the death of Dr. Hans J. Kiaer of Drammen, Norway, who died on April 2 last, at the early age of 34. Dr. Kiaer had followed the study of mathematical astronomy at the Universities of Christiania and Cambridge and at Paris, and had published essays on gravitational subjects. Our readers may remember a communication from him in our number of October last.

An International Conference, arranged by the Royal Society to consider schemes for making an International Catalogue of Scientific Literature, will shortly take place. A reception of the delegates will take place at the Royal Society's rooms, Burlington House, on the evening of July 13.

The Astronomer Royal is on his way to Japan to observe the Solar Eclipse of August next. The other members of his party, Prof. Turner and Capt. Hills, left England some weeks earlier.

Dr. Gill, C.B., F.R.S., has been elected Correspondent of the Paris Academy of Sciences.

Erratum.—In Mr. Ellis's article of last month, p. 231, line 10 from bottom, *for* "their regular" *read* "the irregular."

From an Oxford Note-Book.

The note-book has gone on a journey to see the eclipse of August 9, taking the scribbler with it. Some indulgent editors would no doubt have regarded the occasion as a well-deserved holiday for their contributors, but no such idea seems to have presented itself to the mind of the director-in-chief of this journal. He has merely inquired whether the note-book would wish to change its name for the time being, calling itself a rover, or a rolling-stone, or other name suggestive of foreign travel. This shall be left to his editorial wisdom, merely remarking that the identity of the book is unchanged and that it hopes to return intact to Oxford about the end of September. Meantime such stray jottings as can be set down shall be sent at intervals to the relentless one; but, *en revanche*, not only will he have to take what he can get, whether suitable to the pages of an astronomical magazine or otherwise, but (blessed thought!) he will have to correct the proofs!

Supposing the Editor to leave the heading unchanged, it may be well to specify exactly the amount of the error involved in the assumption that these actual words were written at Oxford. The good steamship 'Sardinian' (Allan line) left Liverpool on Thursday, May 28, at ten o'clock in the evening, the passengers having been embarked, for some unknown reason, six hours previously. She is now (June 4th) nearing the south point of Newfoundland, after a fairly quick and easy run. Icebergs have been seen since midnight, and more are expected. The temperature on deck is 38°, and a gentle drizzle is falling: the temperatue of the smoking-room is not known, as the thermometer cannot be seen for smoke and is broken; but it must be over 100°; and we consider the saloon a better place, although near the screw. Our chief male singer is crooning melodies to his own accompaniment on the "autoharp" and to an admiring female audience. Otherwise we are very comfortable, and hope to be in Montreal on Monday next. Why I should regard this as a fitting opportunity to write notes, I am somewhat at a loss to explain.

ONE of the advantages of travel is the acquisition of a vast amount of curious information from fellow-travellers, especially those with whom one is thrown into contact for a considerable period—say a week or ten days at sea. Under these circumstances the ordinary man produces for the benefit of his companions stores of knowledge which he does not impart to the casual stranger, not from want of amiability but from lack of opportunity. My neighbour at table, Colonel Rivers, has told me several most interesting facts during the meals we have eaten together, as, for instance, that there is considerably more nutriment in the skin of the grape than in its pulp: the ratio, he says, has been ascertained to be about 4·17. Then, again, he says that in Burmah they distil a native spirit which will dissolve a Martini-Henry bullet. He has a little solution of bullet with him, but it is unfortunately in his box in the ship's hold. Further, he informs me that a ship's biscuit, if aimed at a midshipman's head, will break his skull. He has not with him, at the moment, a midshipman to whom this has been done, but he could probably procure one if desired. I think these things ought to be generally known.

AMONG the disabilities of the fair sex which have been mentioned in argument by those who oppose their complete equality with men, I do not remember to have seen mentioned the greater susceptibility of women to the ills of the sea. During the first few days of a voyage the attendance at *table d'hôte* is largely male. It must be admitted that there are many circumstances which detract from the reality of this apparent disparity between the sexes — one of the most important being probably the greater reluctance of a woman to appear in public under conditions of more or less distress. The following incident I give merely as a fact, without professing to show clearly its bearing on the main question. Coming on deck for a few minutes in the early morning of the fifth day out, I saw a fair lady, who had not appeared since the first day, seated in a deck chair having some breakfast; and made bold to congratulate her on being again able to enjoy the pleasures of the table in some degree. She thanked me sweetly, regretting at the same time that she scarcely as yet deserved the felicitations, as she felt far from well. As I turned away my eyes fell on the dish with which her delicate appetite was trifling. It was a beefsteak and onions!

MONDAY.—Our cold discomfort of Thursday was soon over. Friday was fine and sunny; and Saturday and Sunday were spent in the river St. Lawrence under conditions that left nothing to be desired. This approach to America is certainly magnificent, and one feels quite repaid for the extra day or two and the icy winds. It is difficult to realize, as one looks out on the broad expanse of waters glistening in the warm sunshine, that only six weeks ago there was ice from shore to shore, strong enough to bear a railway train. Now, not only is the river itself thawed, but it seems to have the effect of melting any remnants of reserve among the passengers, who greet one another with radiant faces and order champagne for dinner. This reminds Col. Rivers of a man in the service who used to eat champagne-glasses for a wager, thus dispelling the notion that powdered glass is a slow poison. This man ate many such glasses and thrived on them; but one day he satisfied the cravings of a depraved appetite with a galvanized iron bucket, which made him ill, and he died some time afterwards. Later in the evening Col. Rivers gave the following tentative explanation of the so-called sea-serpent:—A sailor hooked a shark with a line and a lump of pork; but before he could haul him in, another shark imbedded his teeth in the tail of the first, only to be himself seized in the tail by a third shark, and so on up to eight sharks! [A man across the table who here enquired "why stop at eight?" was frozen solid by a look from the Colonel.] "At this point the line broke," went on the Colonel impressively, "but the ship's doctor, whose name was Ferguson, having a good pair of glasses followed the receding line of sharks and saw it gradually increase to 40 in number, when he lost it. But a few days later a ship passing near the spot reported a sea-serpent which stretched from one horizon to the other." This explanation is certainly ingenious.

AT Montreal we get some English newspapers of a week ago, and I see for the first time a short account of what happened at the Paris conference of superintendents of ephemerides and their colleagues. One resolution they have agreed upon must surely be on the right side, viz. that which restricts the number of decimal places in the coefficients of aberration and nutation to two. We have used meaningless decimals far too long, but this desirable change adopted at headquarters ought to mark the inauguration of a new era.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 243. AUGUST. 1896.

THE BRITISH ASTRONOMICAL ASSOCIATION.

The concluding meeting of the sixth Session of the British Astronomical Association was held on Wednesday, June 24, at University College, Gower Street, W.C., the President, *Mr. E. Walter Maunder*, in the Chair.

Mr. Henry Corder read a paper on "The Leonid Meteor Shower." Mr. Corder said that assuming that the great shower was due in November 1899, it was very desirable that careful observations should be made each November until then, for the purpose of collecting data for subsequent calculations in connexion with the history of the meteor swarm. Among the points it was desirable to settle were, first, the width of the stream each year; second, whether there was any shifting of the radiant-point; third, the time at which any great thickening of the stream took place. During the next year or two the shower would probably gain a good deal in grandeur. Dr. Johnstone Stoney had called attention to the importance of making certain that A.D. 120 was really the date of the capture of the Leonid stream by Uranus, and had suggested that the difference of apsidal perturbation which Jupiter and Saturn would have upon the front, middle, and rear of the swarm would afford a method of determining the question.

Dr. Stoney remarked that the Earth passed through the November stream of meteors in two successive years three times in a century, and this event might be looked for in November 1899 and November 1900. The display might be extended into 1901, and advance meteors might be seen in 1896, 1897, and 1898. The meteors themselves were probably little pebbles weighing about an ounce or two, and travelling, at the densest part of the swarm, at a distance from each other in every direction of about a mile. The thickness of the stream was about 100,000 miles, and the velocity, when it crossed the Earth's orbit, 27 miles a second. The Earth took about five hours to pass obliquely through the stream. If they were favoured with fine weather next November a sudden increase in the number of meteors visible would almost certainly become obvious, and it was most important that every effort should be made to record the time roughly, and the path accurately, of as many of these meteors as possible. The swarm was invisible while in outer space, but it might impress itself on a long-exposed photographic plate. December and January of the present and two following years would probably be the best time for making the attempt in the northern hemisphere.

Miss Brown asked whether it would not be possible for the meteors to be seen by daylight through a telescope.

Mr. Bartlett said such supposed observations were very untrustworthy. He had often seen thistle-down when observing in the daytime.

Mr. Kennedy asked whether every meteor entering our atmosphere was entirely consumed.

Mr. Crommelin inquired whether the meteors might not possibly be due to an eruption on Uranus.

Mr. Hardy asked whether the swarm was wide enough to reach the Moon.

The President asked what exact observations would be most valuable.

Dr. Stoney, in reply, said that the observations of most importance would be those of the actual swarm itself, including the foremost members and those that lagged behind. Mere observations upon sporadic meteors, such as were seen every year, would not be of much service. Undoubtedly all meteors that entered our atmosphere were entirely consumed, but they were a mere nothing to the vast number of the whole stream. He did not think the stream could be due to an eruption on Uranus, although the theory was perhaps worthy of consideration.

The President remarked that if the shower of 1899 was anything like as splendid as that of 1866 there would be ample opportunity for employing photography in accordance with Dr. Stoney's suggestion.

The President then gave an outline of the work proposed to be undertaken by the members of the Eclipse Expedition at Vadsö *.

Mr. Schooling read a paper on "Baily's Beads: a suggested Explanation," by *Mr. Geo. St. Clair.* He referred to the fact that although the phenomenon was occasionally seen, it had never yet been satisfactorily explained, and suggested that the optical principle of interference gave the solution of the problem.

Mr. C. Roberts read a paper on "Saturn and Uranus," describing the results of his drawings of the former planet during 1896, and Uranus on May 25 last. The paper was accompanied by several drawings.

The President remarked that there could be no doubt about the excellence of these and other drawings which Mr. Roberts had submitted to the Association. He was certainly to be congratulated on having an extremely keen sight for delicate and diffused markings.

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* See page 294.

Mr. Holmes read a paper on "The Nebula H 37 IV." After referring to the serious discrepancies in previous observations of this object, he gave a number of calculations illustrating the enormous size of the nebula. Taking a minimum estimate, it must be some 826,000 times our distance from the Sun, and its minor diameter some 75 times our distance from the Sun, so that it would much more than fill the entire orbit of Neptune. Its mass, if its density were only one thousandth of our atmosphere at sea-level, would equal 573,000 Suns, and at a millionth of our atmosphere it would equal 573 Suns. However far from the truth these figures might be, there must apparently be an enormous gravitating force present which must cause extremely rapid motion in the outer portions of the nebula and in its neighbourhood. Motions and changes on a tremendous scale must be there taking place and were worth watching for.

Mr. C. T. Whitmell contributed two papers, of which *Mr. Crommelin* gave an abstract, dealing with the total solar eclipses on Jupiter produced by satellites III. and IV. The writer pointed out that the orbital velocity of these two satellites round Jupiter was less than Jupiter's rotational velocity, and consequently they would always be retrograding when in the zenith of an observer on Jupiter's equator. As a consequence of this, each of these satellites could produce in one day three total eclipses to an observer stationed on Jupiter's equator. In the case of III. the noon totality would last 41 minutes, and would be preceded and followed by totalities lasting 21½ minutes.

The President remarked that Mr. Crommelin had omitted one fact that Mr. Whitmell had drawn attention to, namely, that it was Mr. Crommelin himself who had made the suggestion of the possibility of a triple eclipse in one day due to the action of a single satellite.

Mr. J. A. Biddell exhibited and explained the working of an improved stand for a portable telescope, and *Mr. Salmon* sent a photograph of a cover for an open-air reflector.

After the appointment of Scrutineers for the next Council ballot, and the election of Auditors, the meeting was adjourned till October next.

The Approaching Solar Eclipse.

We give below a list, complete so far as is known, of the stations along the line of totality which will be occupied by observing parties on the occasion of the Total Eclipse of the Sun on August 9 (civil), with in some cases the *personnel* of the expeditions, the equipment, and proposed programme. It need scarcely be said that the principal object is the delineation of the corona, which will be attempted in most cases by photography; but hand-drawings will be made by some observers, which will usefully supplement the photographs by showing the extreme faint extensions of the corona and the small detail near the limb—the points in which the camera has hitherto been least successful. Besides this, at some stations spectroscopes and objective prisms will be used to photograph the spectrum of the corona and prominences, and at a few places the time of contacts will be observed. Meteorologists will accompany some of the parties, and probably the many persons who are going to Norway more as a holiday-tour than to make definite astronomical observations will add considerably to our knowledge of the general circumstances of Solar Eclipses.

Norway, Varanger Fjord.

The British Astronomical Association expedition will be located at Vadsö, on the north side of the Fjord. The spectrum of the corona and chromosphere will be photographed by Mr. Maunder, who will use a small prismatic camera; by Mr. Lunt, who will use a slit-spectroscope; and by Mr. Evershed, with a prismatic camera. Mr. Evershed will also make eye-observations of the spectrum of the prominences before and after the eclipse by means of a grating on a 3½-inch refractor. The corona will be photographed by various methods and with instruments of various focal lengths. Mr. Maunder takes a telescope of short focal length for this purpose. Dr. Downing will make observations of the corona with a polariscope to determine the nature of its light, whether reflected or otherwise. Mr. Green, Mr. Ledger, Miss Brown, and others will attempt hand-drawings of the corona. Mr. Crommelin will make time determinations and will observe the times of contact; Mr. Mitchell is the meteorologist of this party.

In the same vessel—the 'Norse King'—with the above-mentioned expedition goes one of the official expeditions sent by the joint Permanent Committee of the Royal and Royal Astronomical Societies. The chief of this party is Dr. Common, who will be accompanied by Mme. Klumpke, Prof. Naegamvala, Sir Robert Ball, Mr. A. R. Hinks, and Mr. W. H. Wesley. Dr. Common, who will devote his energies to photographing the corona, will probably observe from the neighbourhood of the Fjord. Prof. Porro, the Director of the Turin Observatory, and M. Antoniadi, of Juvisy, also go in this vessel.

Another of the official expeditions sent out by the joint Committee will occupy a position on the south side of the Fjord. The chief work of this party, which is under the direction of Prof. Lockyer, and of which Mr. A. Fowler is a member, will be to photograph the spectrum of the whole limb of the Sun with a prismatic camera of 6 inches aperture.

Drs. H. Mohn and Schroeter, of the Christiania University, intend to station themselves at Vadsö. Dr. Geelmuyden, Director of Christiania Observatory, will also be near the same place, and many other observers of whom we have no information may be expected to be about here.

Nova Zembla.

An English party, consisting of Miss Agnes Clerke, Mr. E. J. Stone, Mr. Shackleton, and others, who have been invited by Sir George Baden-Powell to accompany him in his yacht, will observe from this island.

An expedition sent by the Russian Academy of Sciences, consisting of Prince Golizin, Dr. Backlund (Director of the Pulkova Observatory), and Prof. Lewitzki (Director of the Dorpat Observatory), will also be here. Two zoologists accompany this party.

Finland.

An expedition sent by the Russian Astronomical Society will be stationed at Enontekis. It is proposed to photograph the corona with cameras mounted equatorially, and also to compare the spectrum of the corona with that of helium. Times of contact will also be observed at the station.

Professors Glasenapp and Vuchikhovsky will be stationed in this neighbourhood.

Mouth of the Obi.

A second expedition sent by the Russian Astronomical Society will photograph the corona with fixed cameras.

Olekminsk on Lena.

At this place the duration of totality will be longer by a few seconds than at any other station. The Russian Astronomical Society have sent a third expedition here. The programme is to photograph the corona with a long-focus lens : to take photographs of the spectrum of the corona with two spectrographs, and of the limb of the Sun with a Rutherfurd prism. Time observations will also be made here, and a meteorologist, Prof. Voznesensky, will also be one of the party.

On the Lower Amur.

A party of Russian astronomers will observe here, but no details are to hand.

Japan, Island of Yesso.

On this island, where the duration of total phase will be almost a minute longer than in Norway, there are already stationed several official observing parties. The English expedition sent by the joint Committee of the Royal and Royal Astronomical Societies; a French party, of which M. Deslandres is the chief observer;

a Lick Observatory expedition, sent at the expense of Col. Crocker; another American expedition, under Prof. D. P. Todd, of Amherst College; and, we believe, a party from Harvard College Observatory.

The programme of the first-mentioned party is as follows:—

The Astronomer Royal proposes to take photographs of the corona with the Thompson photoheliograph, with negative enlarger showing an image of the Sun of about 4 inches diameter. Prof. Turner takes photographs of the corona with the Abney lens, in continuation of a long series of such photographs made with it at previous eclipses, and also with a lens by Dallmeyer. Capt. Hills proposes to take photographs of the spectrum of the Sun's surroundings with a slit-spectroscope. The Astronomer Royal and Prof. Turner will use coelostats. Capt. Hills has provided himself with a heliostat of ordinary form.

The work of the Lick Observatory party is also wholly photographic. Prof. Schaeberle proposes to take photographs of the corona with the telescope of 40 feet focal length and 5 inches aperture which he used at Chili on the occasion of the Total Eclipse in 1893; he will also use the Floyd photographic telescope of 5 inches aperture. Prof. Bürckhalter will take pictures with a photographic telescope of 20 feet focus and 4 inches aperture. This party will be accompanied by a member of the staff of the Tokio Imperial Observatory.

On Photographing the Solar Corona.

In the July number of the 'Bulletin de la Soc. Ast. de France' there is published a valuable research on this subject by Count de la Baume Pluvinel, with some useful information derived from his experiments at the Total Eclipse of 1893, which may be abstracted here with advantage, although too late to be made use of for the Eclipse now at hand.

The author having stated the reason of the difficulty that has been found in photographing the corona satisfactorily—namely, that as the light emanating from different points of the corona is of such very different intensity, a photograph which will show the extreme ends of the streamers requires to be exposed for a time that makes the details near the limb quite invisible; and, *vice versa*, a photograph which would show the part nearest the Sun to best advantage would not show the streamers of proper length, owing to inadequate length of exposure,—proceeds to investigate the proportions of the telescope most likely to show all parts of the corona with proper effect.

He begins by stating as axiomatic the law of photographic action—that the effect on a sensitive plate is constant if the product of the intensity of the image and the time of exposure be constant. This law is generally accepted as true *within limits.* We might refer to researches on this subject made by M. Janssen and Capt. Abney, who have found that for every kind of photographic plate there is a maximum value of this product of light by time which gives greatest density of image, and that if this be exceeded there is no greater density of image.

Now the brightness of an image formed by a telescope depends first on the intrinsic brightness of the object photographed, and then on the aperture and focal length of the telescope.

If these quantities be denoted respectively by I, a, and f, the brightness of image $(e) = \mathrm{I} \,.\, 100 \frac{a^2}{f^2}$; and, therefore, if the photographic action be denoted by a, $a = \mathrm{I} \,.\, 100 \frac{a^2}{f^2} t$. The problem Count Pluvinel set himself at the eclipse of April 1893 was to determine what numerical value of the factor $100 \frac{a^2}{f^2} t$ was most efficient to photograph the coronal streamers without fogging the plate by the light from the surrounding sky.

To do this there was constructed a camera-box on a large scale, divided into nine compartments, each furnished with an object-glass of different aperture varying from 5 mm. to 155 mm. The focal length of all of these was about 1½ metres, and the time of exposure being $3^{\mathrm{m}}\ 50^{\mathrm{s}}$, the duration of totality, the values of the expression $100 \frac{a^2}{f^2} t$ varied from 0·24 up to 250. This large camera was mounted equatorially and plates exposed. The developed plates showed the following results:—

The plate which had received a photographic action equal to 0·24 gave a good image of the middle part of the corona. On this plate a certain streamer was shown extended about 15′ from the edge of the Moon.

On the next plate, which had received photographic action equal to 0·84, the corona was more extended, as would be expected: the same streamer was 20′ long on this plate.

The third plate, corresponding to a photographic action 1·42, was submitted to a long development, or otherwise the plate would have been fogged by skylight. On this plate the before mentioned streamer extended to 28′ in length, but the middle part of the corona and that near the limb were completely fogged.

The fourth plate, exposed to a photographic action of 3·24 and developed normally, seemed to give, from a general point of view, the most satisfactory picture. As for the other plates, they gave images grey and uniform, which show that the photographic action was too great. So that it appears, as the result of these experiments at Joal, that with such atmospheric conditions as prevailed there it is not advisable to attempt to photograph the corona with photographic action, as defined above, greater than 4.

At the same eclipse Mr. Albert Taylor in Brazil found that the image of the corona extended as the photographic action was increased to a numerical value of 8·8, but with a value 22 there was a manifest loss of detail in the extreme parts, which leads Count Pluvinel to take the number 10 as representing the photographic action to be adopted in future eclipses, which should be diminished if the illumination of the sky is very intense, and augmented if the duration of totality is so great that the light of the sky would be less than in 1893.

It has been stated above that the law of photographic action is only true between certain limits. With extreme values of the factors *e* and *t*, the effect would not be the same, even though the product *et* were the same, as when *e* and *t* had mean values. Thus if the light intensity be represented by 1, and the time of exposure be 10 sec., the photographic action would be 10; but if the intensity be reduced to 0·4, it would be necessary to give an exposure of about 350 seconds instead of 250 to produce equal action.

This departure from the general law has led Count Pluvinel to suggest a method by which the corona could be photographed without an eclipse. For, it is argued, the corona is not seen because the difference between its light and that of the surrounding sky is too feeble to make any impression on the eye; but since, when the light is very much diminished in intensity, it requires a very much increased time of exposure to produce an effect, and this rate of increase increases enormously as the intensity of light is diminished, it might be possible to use a combination of aperture and focal length which would diminish the action of the sky, so that it would not have any effect on the plate even with a very long exposure, but that this exposure might be sufficient to allow the slightly more intense light of the corona to imprint itself on the plate. This process seems logically correct, in fact this is the principle adopted for photographing faint nebulæ; it remains for some one to try the method on the Sun's surroundings.

The International Catalogue Conference.

THE following is the text of some of the Resolutions * passed at the International Conference organized by the Royal Society to consider the preparation and publication of an International Catalogue of Scientific Literature, and held on July 14, 15, 16, 17 at the Royal Society's Rooms, Burlington House. The official report was published in three languages—English, French, and German.

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* Published in 'Nature,' 1896, July 23.

That it is desirable to compile and publish, by means of some international organization, a complete catalogue of scientific literature, arranged according both to subject matter and to authors' names.

That in preparing such a catalogue regard shall in the first instance be had to the requirements of scientific investigators, to the end that these may by means of the catalogue find out most easily what has been published concerning any particular subject of inquiry.

That the administration of such a catalogue be entrusted to a representative body, hereinafter called the International Council, the members of which shall be chosen as hereinafter provided.

That the final editing and the publication of the catalogue be entrusted to an organization hereinafter called the Central International Bureau, under the direction of the International Council.

That in indexing according to subject matter regard shall be had not only to the title (of a paper or book) but also to the nature of the contents.

That the catalogue shall comprise all published original contributions to the branches of science hereinafter mentioned, whether appearing in periodicals or in the publications of societies or as independent pamphlets, memoirs, or books.

That the Central Bureau shall issue the catalogue in the form of "slips" or "cards," the details of the cards to be hereafter determined and the issue to take place as promptly as possible.

That the Central Bureau shall also issue the catalogue in book form from time to time, the entries being classified according to the rules to be hereafter determined.

That the Central Bureau be located in London.

That the Royal Society be requested to form a Committee to study all questions relating to the Catalogue referred to it by the Conference or remaining undecided at the close of the present sittings of the Conference, and to report thereon to the Governments concerned.

The Conference, being unable to accept any of the systems of classification recently proposed, remits the study of classification to the Committee of organization.

That English be the language of the two catalogues, authors' names and titles being given only in the original languages, except when these belong to a category to be determined by the International Council.

That January 1, 1900, be fixed as the date of the beginning of the Catalogue.

The August Meteors.

These phenomena will recur under very favourable circumstances this year, the Moon being absent from the nocturnal sky, so that with clear weather the shower ought to be successfully observed. The chief point will be to determine the intensity of the shower on the night of the 10th, and this cannot be done unless the firmament is watched continuously and the total number of meteors from Perseus counted. It is unfortunate that the observer who records the apparent paths with the view of fixing the radiant, loses many meteors during the short intervals when his attention is diverted from the heavens. But the determination of the radiant is an important feature and no observation of a meteor shower can be regarded as complete without it.

It is well known that the Perseid radiant has an apparent diurnal motion of about 1° to the eastwards. This fact can be re-observed by anyone who will watch the shower on a few successive nights, and who has previously gained sufficient practice in this class of work to chart the meteor-tracts accurately. The radiants for different nights when compared together ought to exhibit the progressive movement of the radiant very satisfactorily, but the motion will not be a perfectly regular one, as the errors of observation cannot be eliminated. I regard the displacement of the radiant as a comparatively easy feature to recognize, but everything depends upon the care and exactness with which the individual meteor-paths are recorded. It is not important that a large number of such paths be secured, a few will be sufficient for deriving the radiant, the really essential feature being that their directions are accurately mapped and that their positions are not far distant from the centre in Perseus. The luminous streaks usually left by these meteors furnish a useful guide to those engaged in recording their paths.

Meteoric observations are often published in a confident manner by those who have undertaken them for the first time; but it is obvious, from the nature of the work involved, that it requires much practical experience, without which results can carry very little weight.

One interesting point in connection with observations of the Perseids is for several persons to watch simultaneously with the object of obtaining two or more observations of the same objects. The real paths of many Perseids and of meteors from the minor showers of the epoch have been determined in recent years from duplicate observations of the character alluded to, and it is hoped some further materials of the same kind will be gathered during the ensuing display. I subjoin a list of 24 meteors doubly observed in late years near the time of the Perseid maximum.

Date.	Time. h m	Mag.	Height at beginning. miles.	Height at ending. miles.	Length of Path. miles.	Radiant-point. °	°	Observers.
1886 Aug. 4.	10 40	>♀	90	11	168	161	+59	W.F.D. & others.
1887 Aug. 10.	10 47	2	111	43	20	*44	+54	T.W.B. & W.F.D.
14.	13 46	3–4	126	87	78	*53	+57	D.B. & W.F.D.
21.	11 2	♀	80	45	40	264	+61	D.B. & W.F.D.
1888 Aug. 5.	10 18	1–3	69	50	41	*50	+55	G.T.D. & W.F.D.
5.	10 29	3–4	69	48	38	*39	+57	G.T.D. & W.F.D.
5.	10 41	3–4	68	48	41	*43	+51	G.T.D. & W.F.D.
8.	10 10	3–4	65	52	38	318	−13	G.T.D. & W.F.D.
8.	10 6	3–5	70	59	28	*66	+56	G.T.D. & W.F.D.
8.	10 21	3	43	28	26	*40	+60	G.T.D. & W.F.D.
8.	10 27	4	68	48	36	*42	+57	G.T.D. & W.F.D.
8.	11 16	>1	71	61	22	60	+48	T.W.B. & D.B.
13.	11 33	>♀	79	47	48	*43	+56	D.B. & W.F.D.
1893 Aug. 10.	11 0	1	38	23	35	304	−13	H.C. & W.F.D.
10.	11 55	1–♃	107	60	69	*43	+59	H.C. & W.F.D.
14.	11 0	1	60	45	15	294	+51	H.C. & W.F.D.
15.	11 57	♃	58	21	61	186	+74	H.C. & W.F.D.
1894 Aug. 10.	11 35	1–♃	52	16	54	*43	+58	T.W.B. & E.R.B.
1895 Aug. 7.	10 12	2–3	43	28	42	45	+47	H.C. & W.F.D.
7.	11 4	1–♃	74	45	33	333	+36	A.S.H., H.C., & W.F.D
7.	11 28	2	105	63	64	*38	+57	H.C. & W.F.D.
11.	10 7	4	78	62	30	*48	+60	A.S.H. & W.F.D.
11.	10 58	1	95	61	53	*36	+57	A.S.H. & H.C.
11.	11 42	♃	75	52	34	*32	+52	A.S.H. & H.C.

* These are Perseids.

The abbreviations in last column are

T.W.B.	T. W. Backhouse.	Sunderland.
E.R.B.	E. R. Blakeley.	Dewsbury.
D.B.	David Booth.	Leeds.
H.C.	Henry Corder.	Bridgwater.
G.T.D.	G. T. Davis.	Reading.
W.F.D.	W. F. Denning.	Bristol.
A.S.H.	A. S. Herschel.	Slough.

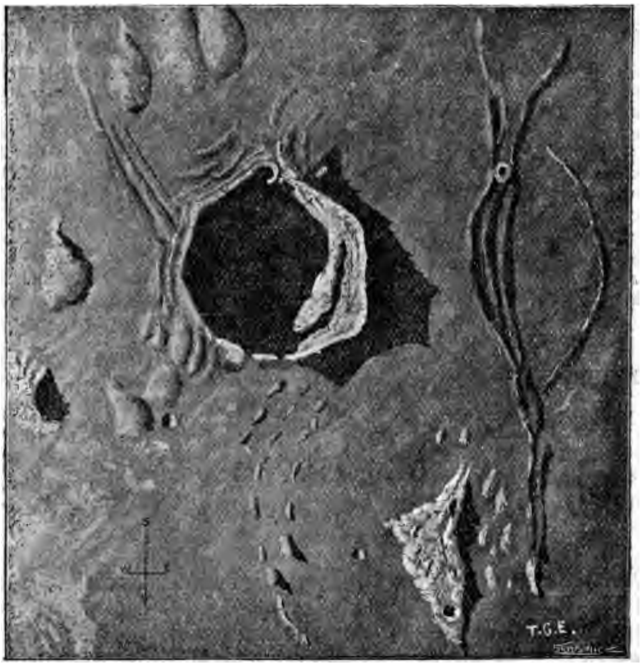
The mean radiant of 15 Perseids included in the table is 44° +56½°, which agrees very well with the best determinations of this shower-centre. The mean height of these Perseids was 81 miles at beginning and 51 miles at ending, while the length of observed path was 44 miles.

Radiants obtained from doubly observed Perseids are not as a rule individually accurate, for these meteors are often placed at great distances from the radiant, and can therefore afford no exact clue to their point of divergence. Moreover, a slight error of only ½° or 1° in the beginning or end of the path, as mapped by one of the observers, will introduce a considerable discordance and throw the radiant out several degrees. For critical purposes, therefore, I regard radiants which are determined from shower-meteors in the usual way as generally more reliable and accurate than those obtained by doubly observed meteors.

Bristol, 1896, July 12. W. F. DENNING.

Selenographical Notes.

Manilius.—This beautiful object, occupying an isolated position in the Mare Vaporum, may be regarded as a typical example of the lunar "ring-plain." Its brilliant rampart maintains a uniform altitude above the floor of about 8000 feet all round, and exhibits on its inner slope some remarkable terraces which are very noteworthy under good definition.



The accompanying drawing is a reproduction of a sketch made at the telescope between 9^h and 10^h on June 17 with a power of 384 on my 8½-in. Calver reflector, and represents the formation at the most advantageous phase for observing the character of the wall and its surroundings. It is evident at first sight that this ring-plain deviates considerably from circularity, its form approximating very closely to that of an irregular hexagon. Two sections of the summit ridge on the south-west are apparently perfectly straight, while the others are only very slightly curved. Similar characteristics may (as I have pointed out elsewhere) be noted in connection with a great number of the so-called rings, large and small, a fact which seems to be utterly opposed to the idea of their having been formed by the ejection of material from a central vent. The shadow of the eastern wall of Manilius is rather remarkable, as is evident from the drawing, which shows it as it appeared at $9^h\ 30^m$ on the evening in question; but probably its peculiarities of shape are to some extent due to the unevenness of the surface on which it falls. Rather more than halfway down the inner slope, a wide irregular chasm is a very conspicuous feature. This evidently consists of a number of inosculating craters, diminishing in size as they proceed northwards. Schmidt draws five of them. Between these objects and the steeper upper section of the rampart there is a number of terraces, separated by shallow valleys, extending concentrically with the summit, but partaking more of a circular form than the latter.

About 20 or 30 miles east of Manilius several steep curved ridges extend from north to south, their shadows under a low morning sun being especially prominent. Close to their southern end stands a crater of some size (Neison's D), which at this phase has a dusky appearance and is certainly less than 5° bright. These ridges appear to form the western side of a large incomplete enclosure, whose eastern boundary is marked by a single and much lower ridge. The short rill ζ in Neison's Map II., situated near these ridges, was not seen on June 17, though I have seen it on previous occasions.

The mountain-mass of triangular shape north-east of the ring-plain, with a number of isolated hills on the east of it and a large bright crater near its northern end, is a much more definite object than it appears to be on any of the published maps. Another smaller mountain on the north-west (Neison's A) seems to be the relic of a degraded ring. Between this and Manilius stands, amid low elevations, a small but conspicuous crater not shown by Neison. The structure of the outer slope of the western rampart of the ring-plain is very noteworthy, especially on the north-west, where several spurs from the upper section of the wall follow a curved course towards the north, trending towards the crater just mentioned. On south-west three long rill-like lineal valleys partially cut into the foot of the *glacis*. There are two craters on the southern border of Manilius, the larger of which is shown in the drawing as just coming into sunlight.

On the Mare a few miles west of the triangular mountain-mass stand two lofty little hills casting long spires of shadow; these are connected with the outer eastern slope of Manilius by a number of small hillocks which follow a very regular curve convex to the west.

Beaumont House, Shakespeare Road,
Bedford, 1896, July 19.

T. Gwyn Elger.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

The Comet of 1647.

GENTLEMEN,—

This comet was seen by a friend of Hevelius (whose name is not mentioned) at Marienburg, in Prussia, on the 29th of September, and apparently was visible there only for two days, being near the Sun at the time of its discovery. At p. 456 of his 'Cometographia,' Hevelius gives a drawing and description of it, as sent him by his friend, for the state of the weather prevented him from seeing it at Danzig. The comet's place was about ten degrees to the south-west of Arcturus, and it had a conspicuous tail shaped like a spear, 10° or 12° in length. The position depicted in the drawing made at Marienburg is the only one known, so that it has not been possible to calculate the comet's orbit. But as some books give the date of appearance erroneously, it may be worth while to correct these. Sir Edward Sherburne published in 1675, under the title "The Sphere of Manilius," a poetical translation of the first book of his 'Astronomicon' (Creech's version of the whole appeared some time afterwards under the title 'The Sphere of Manilius') and added a long appendix. A copy of this work was some years ago presented to the R.A.S. by Mr. Prince, of Crowborough. The appendix contains not only an account of "the most eminent astronomers of ancient and modern times" (which at any rate cannot be accused of not going back far enough, as the first mentioned is Adam), but also a tabular chronological catalogue of comets, with some particulars respecting them. In speaking of this of 1647, he erroneously gives the date as November 29 instead of September 29, and the mistake appears to be copied in the 'Atlas Cœlestis' of John Seller (author of 'The English Pilot' and other works), a small work published in 1677, which contains a set of constellation-maps without star-names, and some remarks on comets and other celestial phenomena.

It may be of interest to quote here Hevelius's description of this comet, which is given in two places (pp. 456 and 886) of his 'Cometographia'; the following is from the latter:—

"A.C. 1647, etiamsi a nemine, quod sciam, Cometa aliquis annotatus sit, tamen die 29 Septembr. vesperi hor. 8.30′ statim post Solis occasum, Marienburgi Prussiæ, Stella quædam crinita apparuit, cujus delineationem, uti ab amico tum acceperam, tam quà faciem, quàm situm, jam Lib. VIII. pag. 452 & 456 exhibuimus. Existebat in Sidere Berenices, non adeò procul a sinistrâ Tibiâ Bootis, 5 grad. minimùm, ab Arcturo plùs minùs 10 grad. & ab humero sinistro 23 vel 24 propemodùm grad. Ad quam Stellam etiam Comam, paullò tamen ad cubitum sinistrum Bootis dextram versùs declinantem direxit; Cuspidem scilicet sursùm Zenith versùs; sic ut instar scoparum erectarum videretur.

Quippe cùm Cometa non ultra 5 vel 6 gradibus suprà horizontem elevaretur, atque statim post Solis occasum Observatio hæc facta sit, fieri aliter haud potuit, quàm quòd Caudam planè erectam ostenderit; Cujus longitudo plùs minùs graduum 12 extitit. De cætero satis conspicua et splendida erat; ita tamen, ut propè caput in eductione splendidior et densior, extremitatem versùs paullò dilutior rariorque; radiis paullatim sese divaricantibus apparuerit: unde in fine quadruplo, imò quintuplo amplior, quàm ad ipsum Caput visa est; adhæc in tres quatuorve distinctos radios excurrebat, instar scopæ dissolutæ, capite aliquantò compressiore, quantum nudis oculis dijudicare dabatur, Arcturo paullò minore existente. Versabatur tum temporis in 8 fermè grad. Libræ, Latitudinem Borealem 26° propemodùm obtinens, atque Caudam in oppositam Solis Regionem projiciens."

It is a remarkable circumstance that, though Hevelius appears never to have heard of any other observation of this comet, we are told by Struych ('Verfolg van de Beschryving der Staarsterren,' p. 32) that it was seen in Holland for for a week ("men zag hem een Week lang") at the beginning of October. He even gives a rough description of its course, which is quoted by Pingré, saying that it passed through Bootis to the north of Arcturus nearly to Corona Borealis, and also says that it was seen by a captain of the Dutch East India Company "te weeten in de Reizen naar Indien, op de wederomkomst, en in Indien zelf." It seems unfortunate, then, that no observations were made precise enough to connect them with that made by the friend of Hevelius at Marienburg, so as to obtain some idea of the orbit of the comet.

Yours faithfully,

Blackheath, 1896, July 29. W. T. LYNN.

Astronomy in Thomson's 'Seasons.'

GENTLEMEN,—

Dr. Orchard has recently presented us with a highly interesting book on the Astronomy in Milton's 'Paradise Lost,' which has directed my thoughts once more to the astronomical allusions in a later poem, Thomson's 'Seasons.' Most persons will remember a passage towards the end of 'Summer' which runs thus:—

> "Amid the radiant Orbs
> That more than deck, that animate the Sky,
> The Life-infusing Suns of other Worlds,
> Lo! from the dread Immensity of Space
> Returning, with accelerated Course,
> The rushing Comet to the Sun descends,
> And as he sinks below the shading Earth,
> With awful Train projected o'er the Heaven,
> The guilty Nations tremble."

And then the poet goes on to speak of the immunity from "superstitious horrors" which they possess who have studied astronomy, enabling them to bid "the glorious Stranger" hail. Now the question occurs, to what comet does he here allude? for it scarcely reads like a mere general allusion to the appearance of comets, or even, as in the reference to comets in the poem in memory of Sir Isaac Newton, to an historic account of a remarkable comet in past time, the one alluded to in that poem being evidently that of 1680, in respect to which Newton first applied his theory of universal gravitation to the motions of a comet. Now the only conspicuous comet which appeared within the lifetime of Thomson was that of 1744, which was discovered by Klinkenberg on 1743, Dec. 9, four days afterwards by Chéseaux, and passed its perihelion on 1744, March 1 *. But 'Summer' was published in 1727, and this led me to turn to the original edition of that poem (it is well known that Thomson made many alterations in successive editions of the 'Seasons'), where I found the above passage had no existence, but in its place a description of what at first looks like one of a meteoric stream, but afterwards appears really to be of a fine aurora (these phenomena were often then spoken of as meteors). And several accounts are given in the 'Philosophical Transactions' of a very remarkable auroral appearance observed on the night of October 8 (19 N.S.) 1726; those of Rev. W. Derham at Upminster, Essex, and of Mr. G. Lynn at Southwick, Northamptonshire, will be found in No. 398 of the 'Phil. Trans.,' and show that Thomson's allusion to the appearance was really suggested by an actual view of it. The aurora was seen not only in England but in many parts of the continent, and as far south as Florence (see 'Phil. Trans.' No. 402). Derham seems to consider it the most remarkable one which had been seen since March 1716.

It is scarcely appropriate to allude to the details here; but the above suffices to show that in this, as well as in the case of the comet, Thomson describes (though poetically) what he had really seen.

Yours faithfully,

Blackheath, 1896, July 1. W. T. LYNN.

Boundaries of Zodiacal Light.

GENTLEMEN,—

As there has been some correspondence about the Zodiacal Light last winter, the following extracts from my note-book relating to the year 1896 may not be altogether out of place:—

9th January, 7^h.—Could be traced faintly stretching along just beneath the Pleiades in the direction of υ^1, κ^1 Tauri. ω, ι, γ Piscium were well within, η just outside. On the other side ν Ceti on the borders of the Zodiacal Light, ξ^1, ξ^2 outside.

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* It was first seen in England by Thomas Phelps at Lord Macclesfield's Observatory at Shirburn Castle, Oxfordshire, on 1743, December 23 (1744, Jan. 3, New Style), and (cloudy weather having intervened) by Prof. Bliss and Rev. J. Betts at Oxford on 1743, December 31, which would be 1744, Jan. 11, New Style. ('Phil. Trans.' vol. xliii. p. [91].)

12 February.—Early this evening the Zodiacal Light was very conspicuous, β Ceti just outside the border, ω, ι, γ Piscium within, ξ^1 Ceti on the boundary. Very bright nearly as far as η Piscium. It then passed to the east of the Head of Aries, across δ Arietis, and became lost.

28 February, during lunar eclipse.—20 minutes after greatest phase could still trace Zodiacal Light passing between μ and η Piscium, crossing stars δ, τ^1 Arietis, stretching to χ Tauri.

Faithfully yours,
S. J. Johnson.

Melplash Vicarage, Bridport,
1896, July 2.

Total Solar Eclipse 1832, 27 *July.*

Gentlemen,—

I have recently received an account of her recollections of the above, from an old lady who witnessed it when 12 years of age on the Great Cayman (Island) not far from Jamaica, whither she had been conveyed to escape the horrors of the insurrection in the last-named island. The Great Cayman, she states, was "once the rendezvous of pirates, then the home of turtle-catchers and of shipwrecked sailors." The account, of course, relates mainly to the effect on terrestrial objects:—"Not being aware of its approach, the sudden darkness was most appalling; the fowls went back to roost, the horses raced about, and neighed, evidently in terror, the cow moaned and licked her calf as if sympathizing with her in her fear, and the fishermen came on shore. When the darkness was complete there was a bright golden ring, jets of flame were emitted, the stars shone clearly as on a moonlight night, and gradually the appalling darkness passed away, the fowls flew down, and all things seemed bathed in glorious light." The old lady has also furnished me with a rough sketch wherein is depicted a tolerably uniform corona and two large red flames, one curved like a scimitar and situated about 50° to the left of the Sun's vertex.

This is the first observation I have met with of this eclipse. It belongs of course to the 1868 and 1886 returns. Unfortunately in 1904 it is a sea-track throughout; but in 1922 good observations should be got in the north of Australia. In 1832 I find, on referring to 'Francis Moore's Almanack,' the calculated duration was $7^m\ 37^s$ where longest.

The letter also refers to a star being seen from there, "transfixed on the apex of the Moon, when the latter was crescent-shaped near the end of 1831," and to the wondering astonishment and sage remarks of the Caymans thereat. This no doubt refers to the occultation of Jupiter on 1831 December 9.

Faithfully yours,
S. J. Johnson.

Melplash Vicarage, Bridport,
1896, July 2.

OBSERVATORIES.

Cambridge University.—The work done at this Observatory during the period 1895 May 26 to 1896 May 25, as reported to the Observatory syndicate, may be summed up in a very few words, their amount being very far from proportionate to that of the labour they describe. Sir Robert Ball's section of the Report states that he is finishing off the catalogue of stars of the zone 25° to 29° N. dec., which is to form a volume of the Astromische Gesellschaft catalogue; and everyone who has had experience of such work knows how tedious and laborious such a finishing off is: 234 stars have had to be re-observed to perfect the work, and with the exception of stars for determination of clock-error and for adjustments, this is all the meridian observation that has been done. The Catalogue is promised very shortly. The Report says the "printing will probably be completed before that of the Report itself," and it is hoped to publish with it a goodly crop of proper motions and errata in earlier catalogues, such as are often found in preparing a work of this kind. The volume of individual observations is not so far advanced, but part of the copy for press is made.

The Northumberland Equatorial has been used on nearly every favourable night for measuring double and variable stars for parallax and the spots on Jupiter to determine the times of rotation. The results have not yet been worked out. The drawings for the new photographic telescope are being prepared by Sir H. Grubb. The objective for this is being made by Messrs. Cooke and Sons.

Whilst the first section of the Report deals chiefly with the completion of a great work, the second half, for which Mr. H. F. Newall is responsible, treats of the inception of another. It will be remembered that Miss Bruce of New York, among other acts of beneficence towards Astronomy, has provided a spectroscope for use on the 25-inch refractor of the Cambridge Observatory, and the year has been spent in getting this into adjustment. A paper descriptive of this has been communicated to the Royal Astronomical Society (see January number, p. 76), so that nothing further need be said on the subject here, except to congratulate Mr. Newall on having got his instrument ready for work in so short a time.

Harvard.—The Report of this Observatory for the year ending 1895 Sept. 30, which we have lately received, gives, as usual, a very long list of work done during the period; but, first, Prof. Pickering calls attention to the fact that this institution is at about the jubilee period of its existence. No exact date can be assigned for its foundation, for any of several circumstances might be considered as initial; but this is the fiftieth report presented by the Director of the Observatory, and the opportunity is taken to make a brief statement of the past and present policy of the Observatory, which, as an epitome of the work done during the past fifty years, is sufficiently interesting to reproduce here:—

"Two principles have always been prominent in the policy of the Observatory. First, that it is primarily an institution for research. While a certain amount of teaching has been done, care has always been taken that it should not interfere with the main work of the institution. It has generally been restricted to offering students in astronomy the use of the library and instruments under suitable restrictions, and familiarizing them with the work by employing them as assistants. A second principle maintained has been the especial advancement of the physical side of astronomy. While precise measures of position have not been neglected, the policy has been rather to undertake such studies of the physical properties of the stars as would not be likely to be made at other observatories. Under the direction of the Bonds, father and son, the large telescope was extensively used in such work—for instance, in laying the foundation of astronomical photography, in the study of the physical appearance of the Sun and planets, of Donati's Comet, of the Great Nebula in Orion, and of other nebulæ and clusters. Measurements of position are represented by the first precise determinations of the position of faint stars, as those in the Nebula in Orion, and of the northern stars within one degree of the equator. The same policy was continued by Professor Winlock. The physical side of astronomy was represented by his spectroscopic work, by his photographic studies of the Sun, and by the photometric investigations contained in Volume IX. of the Annals. Meanwhile his interest in measures of precision led to his procuring a meridian-circle of the largest size, and taking part in the determination of the positions of the northern stars, by undertaking to observe the zone extending from +50° to +55°. Since then the same policy has prevailed. Precedence has been given to physical work, since less attention is paid to such work elsewhere, and certain portions of our resources, as for instance the Henry Draper Memorial, are available only for such work. Accordingly much attention is paid to photography, photometry, and spectroscopy. On the other hand, much time and money has been spent on measurements of position, and a larger part of the unrestricted income has always been employed in this work than in any other department of the Observatory. The observations of the stars in the zone +50° to +55° mentioned above have been completed, and their publication, with that of the fundamental stars, fills seven volumes of the Annals, containing together over 2000 quarto pages. Besides this, another zone, from −10° to −14°, has been more recently undertaken, the observations (except for the doubtful cases) have been completed, and the final reduction will be made as soon as the places of the fundamental stars can be furnished. Other investigations, like the observations of comets when too faint to be observed with small telescopes, and the search for stars having large parallaxes and proper motions, represent in all a large amount of time and money."

To take in turn the various departments, and beginning with the meridian work, we find that the energies of Prof. W. A. Rogers and his assistant have been devoted to reduction of observations; those made in the years 1880 to 1883 are now being reduced. The reduction of the second of the zones of the Ast. Gesell. Catalogue, which is mentioned above, is proceeding under the direction of Prof. Searle, who made the observations of this zone in the years 1888 to 1892. The East and West Equatorials have been used mainly for photometric work. A new form of polarizing photometer has been used on the East instrument for observation of variable stars of the Algol type and also for variables of long period. The series of photometric observation of the eclipses of Jupiter's satellites has been continued, bringing the total number of observations of this kind to 573.

A long section of the Report treats of the observations made with the meridian photometer. Prof. E. C. Pickering, the Director, who takes this instrument under his especial charge, used it on 115 nights, and has made 73,448 settings. Of this large number of observations some have been used as material for a discussion as to the rate at which it is possible to work without making serious errors, possibly in answer to adverse criticisms which have been made of the results found with this instrument. On one evening 322 stars were observed in the space of about six hours, and this night's work—although the number of stars observed at one sitting is larger on this occasion than on any other of the year—is taken as typical of the work with the meridian photometer since 1882, and on which the Harvard Photometry is founded. These observations have been subjected to a detailed examination to find how many, if any, stars were wrongly identified—that is, if through haste a star was observed other than that whose name was recorded; and it appears that of the 322 stars none were thus mistaken, and though in 63 cases the precaution of noting adjacent stars had been made to guard against this mistake, this turned out to be unnecessary. Further, a test was made to see if the accuracy of individual settings would be increased if they were made at a slower rate. The usual time occupied in making a setting is 9 seconds, and the average deviation of a single setting from the mean of several observations of the same star is ±0·12 of a magnitude; but when the observer attempted to make more accurate settings by spending more time—29 seconds on the average—on the observation, the average deviation was still ±0·12, which leads Prof. Pickering to think that to obtain greater accuracy it is more advisable to increase the number of evenings on which the star is observed than to increase the time. The revision of the stars in the Harvard Photometry has been completed, and the observations are ready for publication.

Details are given of the work done with the Draper Memorial instruments. With the 8-inch Draper telescope 2056 spectrographs have been taken; with the 8-inch Bache telescope in Peru the number taken was 2469. "With these two instruments the attempt is made to obtain photographic charts of the entire sky from the north to the south pole at least once every year." About 400 plates are required for this, and an exposure of 10 minutes is given to each. An accessory has been fitted to the 11-inch Draper telescope for conveniently obtaining a series of photographic spectra of an object at intervals of exactly one minute, which has been used to get such series of U Cephei and other stars of the Algol type, and of the satellites of Jupiter while undergoing eclipse.

The department of the Observatory known as the Boyden Station, which is located in Peru, has been in danger of violent destruction owing to the political disturbances in the country; but in spite of this Prof. Bailey has been able to take a considerable number of photographs with the 13-inch Boyden telescope, which have resulted in the discovery of variable stars, already announced in the Harvard Circulars. The Bruce Photographic Telescope, which is eventually to have its home in Peru, is nearing completion.

PUBLICATIONS.

THE INDIAN CALENDAR *.—We have received a book having this for title, which it would be a presumption to criticize even if such a course were possible. It appears that in the different native provinces of India many different systems of time-reckoning are used, depending in some way on astronomy, and all more or less complicated. Naturally this has caused some confusion and bewilderment, not only to those who are engaged in deciphering Indian inscriptions and to compilers of Indian history, but also to the officers of the Indian law-courts, where documents are sometimes produced bearing date previous to those of any existing almanac. A remedy being required for this state of things, the Government of Madras appealed to Mr. Sewell, who has produced this valuable book, which gives tables for converting any Indian date falling between the years A.D. 300 and 1900 into its equivalent date A.D., and *vice versâ.* In the course of the work Mr. Sewell had occasion to seek the help of several astronomers and persons who had studied this subject—Prof. Jacobi, Dr. Schram, Prof. Kielhorn, Dr. Fleet, Dr. Burgess, Prof. Turner, Mr. T. L. Nardu, and Pandit Sānkara Dikshit, whose help is freely acknowledged; the last-named gentleman showed such an interest in the work that the book is published under his authorship jointly with that of Mr. Sewell.

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* 'The Indian Calendar,' by Robert Sewell, late of H.M.I.C.S., and Sānkara Bâlkrishna Dikshit. With Tables of Eclipses visible in India, by D. R. Schram. (Swan Sonnenschein and Co., 1896.)

Having thus stated the reason for the existence of the book, there is little left to be said of it. The introduction to the Tables is reading of much interest, giving as it does descriptions of various kinds of calendars in use in India; and the Appendix to the book, which is a list of all the Eclipses in India, with elements for computing the locality in which they are visible, extracted from Oppolzer's 'Canon' by Dr. Robert Schram of Vienna, will no doubt be found useful. The name of the compiler is sufficient guarantee for its accuracy and completeness.

MOSCOW OBSERVATORY 'ANNALS'*.—The latest volume of this series, published under the direction of Dr. W. Ceraski, contains various papers, mostly of moderate length, by various members of his staff. It may be sufficient to note the subjects of these. There are three papers on photometry. Dr. Ceraski has made observations of this kind on the stars in the cluster χ Persei, and Mr. Blajko of the variable stars β Lyræ, η Aquilæ, β Persei, and Mira Ceti. Other papers give details of the observations of the Transit of Mercury in 1891, of occultations of stars by the Moon, of phenomena of Jupiter's satellites, and a determination of the latitude of the observatory. Researches of a different class are notes on Encke's and Kowalski's methods of computing double-star orbits, some practical applications of a Henrici's harmonic analyser, lately presented to the observatory, and a short note on the Sun's temperature by Dr. Ceraski. The staff of this institution has lately undergone some changes, which seems to be a common occurrence in Russian observatories at the present time.

TRIANGULATION OF THE CLUSTER IN COMA BERENICES.—Vol. I. of Part V. of the 'Transactions of the Astronomical Observatory of Yale University' consists entirely of measures with deduced results, of stars in the above cluster, made with the heliometer by Dr. F. L. Chase, assistant in the observatory. The whole group of 32 stars are almost all contained within a nearly equilateral pentagon formed by five stars at the angles, and these five stars, with another almost at the centre of the pentagon, are taken as base points of the triangulation. The positions of the stars in the cluster relative to them depend almost wholly on observations of *distance*, which with the heliometer are known to be much more accurate than those of position-angle. The positions of these fundamental stars are deduced from measures of distance and position-angle relative to one of them (Piazzi xii. 57), whose place was determined by modern observations at four observatories, and hence the final result is a table of Right Ascensions and

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* 'Annales de l'Observatoire Astronomique de Moscou.' Deuxième série. Vol. iii. livraison ii.

Declinations for epoch 1892·0 of the 32 stars of the cluster depending on the place of this star, which, it seems to us, would have been improved if the R.A. had been given in ${}^{h\,m\,s}$ instead of ${}^{\circ\,\prime\,\prime\prime}$.

The evidently careful way in which the work has been carried out will make it a valuable basis for a further discussion of relative proper motion, if the work be repeated twenty or thirty years hence.

CHANDLER'S THIRD CATALOGUE OF VARIABLE STARS.—Any remark as to the increase of astronomical activity in recent years without adequate evidence in support might appear as a mere platitude, to which we hesitate to give expression; but there are two branches of the science whose growth can be measured with numerical definiteness. One of these is the discovery of minor planets, whose number, by the way, has not lately been growing at so great a rate as it was a few years ago; the other is the observation of variable stars; and of the large amount of work now going on in this branch we are reminded by the appearance of Dr. Chandler's Third Catalogue, lately published in No. 379 of the 'Astronomical Journal.'

Dr. Chandler's first list was published in 1888, and contained 225 stars, which were all that were known at the time. His second catalogue, published in 1893, contained 260 entries. Since that time, as he says in the introduction to the present work, he has endeavoured to keep pace with the rapid accumulation of new material by the occasional issue of Supplements, but the time has now arrived when a new edition of the catalogue is necessary, incorporating everything up to date. This new catalogue contains 400 stars, and is constructed in every way similar to the previous edition. The places of the stars are given for epoch 1900·0 and also for 1855·0, with columns containing the annual variation in both coordinates. The columns relating to the variability show the magnitude at maximum and at minimum, the interval between maximum and minimum, the whole period between two maxima, and the date of a maximum; but in some cases these latter details are not given for want of data for their determination, and we have only the extreme magnitudes. There is also a column giving the redness in a scale ranging from 0 to 10. Notes are added, both in the catalogue itself and in an appendix, giving peculiarities of variability and the names of the discoverers, with other remarks of an historical and miscellaneous character; in fact, the catalogue gives as complete information on the subject of variable stars as could be desired, although Dr. Chandler regrets that he had not more space at command to enable him to increase these notes.

The following paragraph, extracted from the introduction to the catalogue, is encouraging:—

"These columns illustrate how remarkable has been the degree of uniformity and completeness of the observation of the phenomena and the consequent development of our knowledge with regard thereto during the past few years. Very few stars within reach of the astronomers of the northern hemisphere, who have so actively devoted their energies to this class of work, have been seriously neglected. It is especially interesting to note the fact that this harmonious development has been attained without any concerted scheme of 'co-operation,' but by the free will and independently planned efforts of individual volunteers, each discriminatingly directing his work in accordance with his means and situation. Such a satisfactory result could hardly have been reached so effectually by a formal organization of work directed from headquarters, prescribing and circumscribing the operations of each participant, and destroying, by its benumbing influence, the enthusiasm which springs from the individual initiative of the observers themselves."

NOTES.

Comet Notes.—There is an article by Karl Schwarzschild in Ast. Nach. 3361 on the stability of the motion of comets captured by Jupiter. His researches appear to tend to the conclusion that comets introduced into the solar system by Jupiter are not likely to remain permanent members of the system, but in most cases the perturbations produced by Jupiter will, sooner or later, convert their orbits back again into parabolas or hyperbolas.

The following ephemeris of Brooks' Comet (1889 V.) is for Berlin midnight:—

	R.A.			S. Dec.			R.A.			S. Dec.	
	h	m	s	°	′		h	m	s	°	′
Aug. 4....	22	37	2	18	37	Aug. 20....	22	28	39	19	3
8....	22	35	26	18	44	24....	22	25	59	19	6
12....	22	33	27	18	51	28....	22	23	16	19	6
16....	22	31	10	18	58	Sept. 1....	22	20	36	19	4

The brightness continues to increase pretty rapidly.

Swift's Comet (1896 III.) was observed at Bordeaux up to June 12, but was then exceedingly faint.

The following orbit of this comet has been deduced by Mr. Aitken from numerous observations extending from April 17 to May 25 (Ast. Journ. 577):—

$$\begin{array}{lll} T = 1896 \text{ April } 17{\cdot}64665 \text{ G.M.T.} & & \\ ☊ \ldots\ldots\ldots & 178^\circ\ 15'\ 58'' & \left.\vphantom{\begin{array}{l}1\\1\\1\end{array}}\right\} 1896{\cdot}0. \\ i \ldots\ldots\ldots & 55\ \ 34\ \ 16 & \\ \omega \ldots\ldots\ldots & 1\ \ 44\ \ \ 8 & \\ \log q \ldots\ldots & 9{\cdot}753114 & \end{array}$$

The observations are well satisfied, showing that the orbit does not deviate sensibly from a parabola.

'Bulletin Astronomique' for July contains the following elements of Swift's periodic comet (1889 VI.) by M. Coniel:—

Epoch 1889 Dec. 23^{d}·0 Paris M.T.

M	2° 35′ 20″	
π	40 10 47	1890·0.
☊	330 24 52	
i	10 16 33	
ϕ	43 12 15	
μ	397·92	
log a	0·6335	
Period	8^{y}·92	

He considers the period uncertain to the extent of 0·9 years. This comet is interesting from having the longest period of any member of the Jovian family of comets. Its least distance from the orbit of Jupiter (0·70) is also greater than that of any other member of the family. A. C. D. C.

Minor Planet Notes.—The following planets, discovered by Prof. Wolf, have been named:—

No.	Date of discovery.	Name.	No.	Date of discovery.	Name.
330	1892 Mar. 18.	Adalberta.	351	1892 Dec. 16.	Yrsa.
341	Sept. 25.	California.	385	1894 Mar. 1.	Ilmatar.
342	Oct. 17.	Endymion.	391	Nov. 1.	Ingeborg.
343	Nov. 15.	Ostara.			

It will be remembered that the name Ilmatar was given to a planet which was subsequently found to be identical with (298) Baptistina. The assignation of the name to another planet is to be regretted as likely to cause confusion.

Ast. Journ. 377 contains an investigation by Prof. A. Hall of the perturbations of Nemausa of the first order produced by Jupiter. He deduces new elements of the planet from observations made at 8 oppositions, extending from 1858 to 1892.

Herr Harzer considers that there is some error in M. Ravené's result for the total mass of the group of minor planets referred to last month, and that a mass 18 times as great would be required to produce the observed motion of the perihelion of the orbit of Mars. A. C. D. C.

News from the Eclipse Expedition to Japan.—The following extract from a letter from the Astronomer Royal, posted at Vancouver, July 13, gives a graphic account of some difficulties experienced in pursuit of science:—

"We have had rather an exciting journey through the mountains, the line having been blocked more or less for the last ten days through floods. When we got to Banff (on the east slope of the Rockies) we found no train had been through for 4 or 5 days; then one got through from Vancouver and we started, but after struggling through water and 'washouts' of the line we were pulled up at Glacier House (on the west slope of the Selkirks) an kept there for 36 hours while they mended a bridge 3 miles on, the foundations of which had been washed away. As it was a wooden trestle bridge 100 feet high and about 1000 feet long, and it had to be blocked up 6 or 8 feet where it had broken down, this took some time, and I began to be nervous about missing the steamer; but we had no further mishap, and arrived (at Vancouver) yesterday morning early. The instruments, I was glad to find, had arrived safely and they seem to be all right, so now I feel comfortable in my mind. We have had a very good time and enjoyed the journey through the mountains greatly. The scenery is very fine, and we had the additional excitement of the floods. One train loaded with valuable tea (the new crop) fell into the river Fraser a few days ago and the engine driver was killed. We are now on our way to Japan, touching at Victoria, Vancouver Island."

CAUSE OF THE SALTNESS OF TERRESTRIAL SEAS.—In the course of a discussion at a recent meeting of the French Astronomical Society, M. Janssen threw out the following suggestive idea. If we consider the composition and order of superposition of the metals in the chromosphere, we see that sodium is the most important and most scattered; then come magnesium and calcium, so that if a sudden cooling took place, and the hydrogen of the solar body combined with oxygen to form an ocean, this ocean would immediately imprison chlorides of sodium of magnesium and calcium, and would present exactly the same composition as that of our terrestrial oceans. Why should we not think that our salt seas were thus formed?

ROTATION PERIOD OF THE "GARNET" SPOT ON JUPITER.—It may be remembered that last autumn two well-defined dark spots, hitherto unobserved, were seen on the disc of Jupiter. To the second of these, which was remarkably well defined, so that it was mistaken more than once for the shadow of a satellite, M. Antoniadi, who first saw these spots, gave the name the "garnet" spot. Lately Dr. Rambaut, at Dunsink, has communicated to the Royal Dublin Society some observations he has made to determine the time of rotation of this spot, the interest of which lies in the fact that, as zones of different latitudes on Jupiter have an angular rotation of different amount, just as is the case on the Sun, this new spot afforded opportunity for a redetermination of the rate of the particular zone in which it was seen. Observations of the time of transit of this spot over the central meridian of Jupiter were made, and after correcting for parallax, velocity of light, and phase, the period of rotation of this spot whose zenographical latitude is $+13^{\circ}$, was found to be $9^{\mathrm{h}}\ 55^{\mathrm{m}}\ 33^{\mathrm{s}}{\cdot}36 \pm 0^{\mathrm{s}}{\cdot}53$, which is about the average period of the zone in which it lies. and "agrees within one-fifth of a second with the value deduced by Schroeter 109 years ago from 242 revolutions of a spot: a fact which goes to show that there has been no permanent change in the period of rotation of this region in the interval which has elapsed since then."

WARM WEATHER IN JULY.—During the course of the hot sultry period which marked the greater part of the middle of the month of July, the thermometer on the Glaisher stand at the Royal Observatory passed above 90° on two occasions, viz. on July 14, when a reading of 91°·1 was recorded, and on July 21, when it was 90°·3. [The highest readings recorded in a Stevenson screen on these days were 87°·6 and 87°·5 respectively.] Under similar conditions of exposure on the Glaisher stand there have been 26 instances recorded in the preceding 55 years of temperatures exceeding 90° in July, the highest having been 97°·1 on July 15 in 1881, closely approached by 96°·6 on July 22 in 1868. In the past 8 years (1888–1895) there were no readings in excess of 90°.

Referring to mean temperatures, we find that on the 9th of July the daily mean value was 10°·1 above the average, and on the 14th it was 10°·2 above, but that only two days later (viz. on the 16th), a cold northerly current with rain having supervened, it was 8°·5 *below* the average. *This change was very severe.* Again, on the 21st the excess of mean temperature was 10°·6. The drought has continued throughout the month, and the 1896 rainfall to the end of July is now more than 5 inches in defect as compared with the average amount.

A NEW THEORY OF THE SUN.—Prof. Fényi, of the Haynald Observatory, Kalocsa, in the June number of the 'Astrophysical Journal' puts forward views of some novelty in an attempt to explain certain observed phenomena of the solar surface. First he points out as a difficulty requiring explanation that whereas calculation shows that a large heavenly body, other things being equal, should have a shallow atmosphere, the observed great height of prominences and the corona as seen in an eclipse have always been taken as showing that the Sun has an enormously deep surrounding. And although on the surface of a body with a radius equal to that of the Sun the pressure should be theoretically enormous, this is contradicted by the immense velocities shown by observations with the spectroscope. Prof. Fényi does not deny the reality of the observations and the interpretation hitherto assigned to them—that is, he quite admits that matter does move on the Sun with immense velocity, and his purpose is to explain these inconsistencies. The key to the problem, he thinks, lies in the facts that the solar atmosphere is actually quite shallow, and, secondly, that the expansion of a mass of gas cannot take place instantaneously. If a mass of hydrogen of great temperature be ejected from the Sun, it will reach the outer free space without having expanded completely on account of its great velocity of ejection, but will then expand comparatively slowly; in fact Prof. Fényi shows that if a mass of hydrogen of the size of our Earth were thus ejected. not until after 7 minutes would its radius have diminished to one half its original size, and this delay would account for many of the eruptive prominences observed. The expanding hydrogen as it cools condenses, he says, into a mist and reflects the light from the Sun, and it is this which is called the corona and white prominences; and it is pointed out, in confirmation of this, that Prof. Schaeberle, in his examination of the corona as seen in the eclipse of 1893, found that all the outer streamers were elliptic or parabolic curves having the Sun in the focus, such as would be traversed by bodies ejected from the surface of the Sun into a non-resisting medium. The theory is further extended to explain the existence of faculæ. After the masses of hydrogen projected from the solar surface have cooled, they will complete their trajectory and return to the Sun with the same velocity with which they started. They therefore rush into the solar atmosphere with great velocity and become heated again, much as meteors in the terrestrial atmosphere. Being heated thus by friction, and also by radiant heat from the Sun, they shine more than the surrounding surface; and as these masses of hydrogen, now comparatively small, collide with oppositely directed streams, they spread out and take the appearance characteristic of faculæ. The fact that they occur chiefly in the sun-spot zones is explained on the ground that the eruptions of which they are the consequence take place in these zones. In giving this very sketchy outline of the theory we feel we have scarcely done it justice. The author has laid down his points with much clearness and considerable numerical illustration.

The name of Lord Macclesfield has been brought to our notice in several ways during the past month. First, the sixth holder of the title has recently died, amid much regret. An ancestor of his is mentioned by Mr. Lynn in his letter on p. 306; and again in 'The Leisure Hour' for July there is an especially entertaining article by Mr. H. Rix on "The Presidents of the Royal Society," which naturally mentions this same Earl of Macclesfield, who was President of that learned body from 1753. The following paragraph may be considered worth reproducing:—"He was, moreover, himself a mathematician of high repute and a practical astronomer. At his observatory at Shirburn Castle he often passed the night in observations. His friend Bradley was his occasional assistant, but he afterwards trained two of his servants to aid him—Thomas Phelps, originally a stable boy, and John Bartlett, who had been a shepherd and had taught himself mathematics and astronomy. It was Phelps who discovered the great comet of 1743. Macclesfield was mainly instrumental in procuring the change of style in 1752. He communicated to the Royal Society on May 10, 1750, a preparatory paper entitled 'Remarks upon the Solar and the Lunar Years,' made most of the necessary calculations, and spoke to the question in the House of Lords. The fact of his consequent unpopularity is well known, and the story is often told how, when his son was standing for the county of Oxford in 1754, the mob assailed him with cries of 'Give us back those eleven days your father stole from us.'"

MR. RIX's article is illustrated with a series of very excellent portraits of thirty-four Presidents, those of only two being missing, and of the two present Secretaries. Of these thirty-four we may count seven as astronomers—Wren, Newton, Lord Macclesfield, Lord Morton, Lord Rosse, Lord Wrottesley, and Sir George Airy.

A PARTIAL Eclipse of the Moon is predicted for August 22 (morning of August 23), which is of little interest to observers on this side of the Atlantic, as first contact with the shadow does not take place until Aug. 22^d 17^h 24^m, and the Moon has set at Greenwich at 16^h 58^m. The circumstances are more favourable in America. Magnitude of the eclipse is given as 0·734.

DR. T. J. J. SEE, of Chicago, asks us to publish the following:—"Having joined the Lowell Observatory for the purpose of undertaking a survey of the Southern heavens for the discovery and measurement of new double stars and nebulæ, I desire to state that for the next two months my address will be Lowell Observatory, Flagstaff, Arizona; after Oct. 1 the address will be Lowell Observatory, City of Mexico, Mexico."

THE Astronomer Royal, Mr. W. H. M. Christie, and M. van de Sande Bakhuyzen, Professor in the University of Leiden, have been elected Correspondents of the Section d'Astronomie of the Paris Academy of Sciences: the first to fill the place of the late Dr. Hind; Prof. Bakhuyzen in place of Prof. Newcomb, who has been elected an Associate of the same Section.

MAJOR-GENERAL M. RYKATCHEW has been appointed, by the Russian Imperial Academy of Science, Director of the Central Physical Observatory of St. Petersburg, in place of Dr. Henry Wild, who has resigned.

FROM AN OXFORD NOTE-BOOK.

MONTREAL is a city which those who have been once there are glad to revisit, and those who see it for the first time are glad they have not missed. It is wealthy and prosperous, but has not yet had time to get crowded and dirty, and though essentially modern, is still sufficiently home-like. There are electric lights and trolley-cars and iced drinks, but there are plenty of people also who know that life does not consist wholly in these. This commendation of Montreal is not new; others have previously testified to the same effect, but in spite of this a great many people continue not to go there.

THE British Association was invited to Montreal in 1884, and the remembrance of the visit is still fresh in the minds of both hosts and guests. Next year Toronto is to welcome the same body; and the 10 hours' journey between the cities is so relatively small that there will be many points of similarity between these two trans-Atlantic meetings of the Association. Those who revisit Montreal next year have a great surprise in store for them, in the development of McGill College. This College was already a thriving institution in 1884, and the interest taken in it by the British Association was shown by the establishment of a B.A. Gold Medal and Exhibitions at the College. But since that date the munificence of Mr. W. C. MacDonald, of Montreal, and others, has transformed the whole place. Buildings for the teaching of Engineering and of Physics, as well as a library, have been erected and equipped on a scale calculated to take away one's breath; and another building for chemistry and a fine Observatory are projected. In the Physics building we found Professors Callendar and Cox working hard at the Röntgen rays; they had just obtained evidence of a magnetic deflection of the rays, and were entering upon other important experiments in the intervals allowed them by numerous doctors who had urgent need of the rays for medical purposes.

THIS is not the place to describe all we saw at the McGill College, or even a part of it; but I must record, however irrelevantly, a brief visit to the medical department. Having a few minutes to spare, Professor McLeod asked Mr. Cooke if we might see some of his curiosities. He promptly took down from a glass case two pieces of vertebral column, mounted on wooden stands. "Murderers' necks," he explained laconically; "one broken, the other wasn't. I thought it might amuse the boys to have 'em here." Then indicating another glass case with a wave of the hand—"Suicides," he explained; "bullet in the skull, you see." Then—"This is a piece of the first subject we got under the Anatomy Act; upstairs is the last one we stole." And so on. Having healthily morbid appetites we enjoyed this visit very much.

THE new Observatory has not as yet advanced beyond the purchase of a site for it; but even in this the lavish nature of Mr. MacDonald's benefactions is made apparent. He has secured 33 acres on the top of a hill near Montreal—the whole summit of the hill, in fact, down to 50 feet from the top; and thither Professor McLeod conducted us one morning after a most delightful drive on "the Mountain," of which the hill is an adjunct. The advantages of such a situation for an observatory are manifest. The hill is not nearly high enough to enable the Observatory to rank as a "mountain observatory," with special climatic advantages (which I take to be the present accepted meaning of the term), but there is a clear horizon nearly all round, and there should be no difficulty in getting good terrestrial marks for instrumental adjustment in any azimuth. An instrument of precision, such as the new altazimuth at Greenwich, would thus be able to determine local changes of azimuth, if such exist, with great completeness; and now that we are entering upon such discussions as the discovery of latitude variation brings in its train, the importance of such an observatory cannot well be over-estimated. But nothing is as yet settled about the new building or its instruments, and astronomers who have seen what Mr. MacDonald has done for other sciences will be very eager for news of the observatory.

IT is almost a pity that Montreal comes so early in the journey across Canada, for there is a desolateness about some of the civilization subsequently met with which is rather depressing. Possibly we were unfortunate in our methods. We chose the "Lake Route," and without stopping at Toronto, took steamer through Lakes Huron and Superior. The steamer is certainly cooler than the train, but we did not find it so interesting, as the coast is seldom in sight; and the choice of route involved spending a whole hot day at Fort William, where there is nothing whatever to see or do. To get on board the train again was a real relief, and we almost wished we had come by it all through. The rapidly changing scene, with the glimpses of Canadian settler life along the route, make travelling far less tiring than might be supposed; and then one's physical comforts are admirably looked after. When we reached the prairie, the real grass prairie, our spirits rose quite high. By the space of one day we saw no trees or shrubs, and never tired of the absence of them. I suppose to those who have read Fenimore Cooper on the European side of the Atlantic the prairie is even more fascinating than Westminster Abbey to a Canadian. And then having gone to sleep when we could no longer see the billowy waves of grass, and a magnificent aurora had disappeared, we woke next morning to a view of the Rockies, and by eight o'clock were swimming in a warm sulphurous pool at Banff—where, indeed, we still are.

BANFF pleases us very much. Besides the bathing in curious caverns, there is a little mild mountaineering to be done; and one day we spent in helping to open the hotel at Louise, where the ice cover had not yet disappeared from the lake. Some paragraphs from a guide-book or one of the illustrated time-tables would come in well here, but I fear they would be struck out by a superior hand. To show what would thus be lost, I give a specimen extract from one of the time-tables. It is not about Canada, but about Alaskan glaciers; that, however, does not much matter.

"Soon after leaving Wranzel, the first Alaskan glacier is seen in the distance, looking like a frozen river emerging from the home of the clouds. The sea is glassy, and a procession of small bergs, broken away from the glacier, float silently toward the south. It is Nature's dead march to the Sun, to melt in its burning kisses and to be transplanted into happy tears. Wild ducks fly past, and from his eyrie a bald-headed eagle surveys the scene—deeply, darkly, beautifully blue—apparently conscious that he is the symbol of the Republic."

THIS morning (June 18) a telegram has been received at the hotel, giving news of the terrible earthquake in Yesso; and we have naturally talked and thought much about it. There is no date given, but we suppose that the Astronomer Royal must have heard the news just as he was leaving England, and M. Deslandres just as he reached Yokohama. We feel somewhat anxious as to whether Professor D. P. Todd had already reached Yesso, as we believe he started somewhat early. As regards the bearing of the outbreak on our own work, the natural reflection seems to be that if such earthquakes represent really the relieving of slowly accumulated stresses, the chances are much in favour of a period of quiescence following a violent disturbance. In the same telegram comes the ghastly story of the wreck of the 'Drummond Castle'; and this is practically the only news we have had from England since leaving it. Truly "no news" seems to be the best.

THESE few notes of the journey will, I fear, seem rather out of date by the time they are printed in the August number of this magazine, with the Eclipse only eight days away. But as we leave Vancouver next Monday, arriving at Yokohama July 6, there will not be an opportunity of sending anything further. Even in the September number, when the Eclipse will be three weeks past and gone, I shall only be able to say something of our preparations; and in the same number there may be a telegram announcing that they have come to nothing! This contingency is grievous to contemplate; but having accepted servitude to such an Editor, I suppose I must use a certain amount of good paper and ink as he commands, and spend good money on the postage of the results. This reminds me that as I was groaning at the vastness of the sum which it cost to "mail" the last batch of notes, Col. Rivers (who is, I am glad to say, going to Japan also) genially insisted that "he was sure the matter was well worth it." He little knew how much he had contributed to the worth. Further, I am reminded that this question of postage of letters is one which had better have been allowed to lie than even a sleeping dog. The other day I had presented to me an envelope bearing an English penny stamp, an Oxford postmark, and an address to a gentleman in "Canada, U.S.A."! I am glad to say, however, that the handwriting was unknown to me.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 244. SEPTEMBER. 1896.

Remarks on the Progress of Celestial Mechanics since the middle of the Century.[*]

THE application of mathematics to the solution of the problems presented by the motion of the heavenly bodies has had a larger degree of success than the same application in the case of the other departments of physics. This is probably due to two causes. The principal objects to be treated in the former case are visible every clear night, consequently the questions connected with them received earlier attention; while, in the latter case, the phenomena to be discussed must ofttimes be produced by artificial means in the laboratory; and the discovery of certain classes of them, as, for instance, the property of magnetism, may justly be attributed to accident. A second cause is undoubtedly to be found in the fact that the application of quantitative reasoning to what is usually denominated as physics generally leads to a more difficult department of mathematics than in the case of the motion of the heavenly bodies. In the latter we have but one independent variable, the time; while in the former generally several are present, which makes the difference of having to integrate ordinary differential equations or those which are partial. Thus it happens that, while the science of astro-mechanics is started by Newton, that of thermal conductivity receives its first treatment, at the hands of Fourier, more than a century later. In addition to these two causes, ever since the discovery of the telescope the application of optical means to the discovery of whatever might be found in the heavens has always had a fascination for mankind. And, as the ability to co-ordinate and correlate the facts observed much enhances the enjoyment of scientific occupation, it has resulted that many who began as observers ended as mathematical astronomers. Thus our science has had relatively a large number of cultivators.

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[*] Presidential Address delivered by Dr. G. W. Hill before the American Mathematical Society, December 27, 1895.

A thoroughly satisfactory history of our subject is yet to be written. We have only either slight sketches of the whole, or elaborate treatments of special divisions of the science, and none of them coming down to recent times.

In the present discourse it is proposed to touch very lightly the more important steps made since the middle of the century, the time at our disposal not admitting fuller treatment.

And first we will take up Delaunay's method, proposed for employment in the lunar theory, but quite readily extended to all classes of problems in dynamics. The first sketch of this method, given of course by the author himself, appeared in the 'Comptes Rendus' of the Paris Academy of Sciences, in 1846. It professes to be merely an extract from a memoir offered for publication in the collections of the Academy, which must, however, have been afterwards withdrawn to make place for the two volumes of the 'Théorie du Mouvement de la Lune.' When this extract is compared with the earlier chapters of the latter work, it is perceived that Delaunay has, to some extent, modified and improved his method in the interim between 1846 and 1860. In this long period nothing appeared from the author on this subject. He must have been profoundly engaged in applying his method to the motion of the Moon. Tisserand's exposition of this method is somewhat more brief than the author's own. But when the necessary modifications are introduced into Delaunay's procedures, to make them applicable to the more general case of the motion of a system of bodies, the establishment of the formulas can be rendered still more brief.

There is one point in reference to Delaunay's method which, as far as I am aware, has escaped notice. This method consists in a series of operations or transformations, in each of which the position of the Moon in space is defined by six variables, the number three being doubled in order that the velocities, as well as the co-ordinates, may be expressed without differentials. The aim of the transformations is to make one half of these, which Poincaré has called the linear variables, continually approach constancy, while the other half, named the angular variables, continually approach a linear function of the time. But at any stage of the process the position of the Moon, as well as its velocity, is definitely fixed by the six variables produced by the last transformation, provided that the proper degree of variability is attributed to them, just as, before any transformation was made, the six elements of elliptic motion, usually denominated osculating, defined them; the point of difference to be noticed being that the more the transformations are multiplied, the more complex becomes the character of the expression of the former quantities in terms of the latter. But, however great may be the number of transformations, the series evolved have always one consistent trait, viz. that the angular variables are involved in them only through cosines or sines of linear functions of these variables, the linear functions being formed with integral coefficients. Now, as in all this work we are obliged to employ infinite series, the question of their convergence is an extremely important one. The inquiry in this respect may be divided into two parts, mainly independent of each other. These are, convergence as respects the angular variables, and convergence as respects the linear variables. The first part is much the more simple. Regarding each of the coefficients of the series we employ as a whole, that is, representing it by a definite integral, it is quite easily perceived that the said series are both legitimate and convergent when, giving the angular variables the utmost range of values, still no two of the bodies can occupy the same point of space. In the contrary case the series are evidently divergent. This condition affords certain limiting conditions for the values of the linear variables. Could we trace these limiting conditions through all the transformations, and obtain by comparison the formulas to which these tend when the number of transformations is made infinite, we should be in possession of the conditions of stability of motion of the system of bodies. The second part of the inquiry relates to the expression of the mentioned coefficients by infinite series proceeding according to powers and products of certain parameters which are functions of the linear variables. It is well known that, in the case of elliptic elements, Laplace and Cauchy almost simultaneously showed that the series are convergent when the eccentricity does not exceed a fraction which is about two-thirds. The determination of the conditions of convergence, after certain transformations have been made in the signification of the elements, is undoubtedly a more complex problem; nevertheless, it seems to be within the competency of analysis as it exists at present.

The discovery of the criterion for the convergence of series proceeding according to powers and products of parameters is due to Cauchy, and is a most remarkable contribution to the science of mathematics. Supposing that the parameters begin from zero values, this criterion amounts to saying that the moment the function, which the series is to represent, ceases to be holomorphic, or becomes infinite, that moment the series ceases to be convergent. Consequently, if a space, having as many dimensions as there are parameters in the case, be conceived, and a surface be constructed in it formed by the consensus of all the points where the considered function ceases to be holomorphic, then, provided the values of the parameters define a point within this surface, that is, on the same side where lies the origin, the series will be convergent. Generally this surface will be closed, and, within it, the function will not take infinity as its value.

One more remark may be made before we leave Delaunay's method. In every operation or transformation half the integrals are obtained without the intervention of the time, and from these solely are obtained the ranges of values for all the linear variables. As no integrating divisors appear in their expressions, it follows that the question of stability is not affected in any way by the vanishing of these. Moreover, the presence of a libration in the angle of operation does not necessitate any change in the procedure. The integrating divisors which appear in the expressions for the angular variables, obtained through quadratures, may cause difficulty, but this can generally be removed by a modification of the parameters employed in the development of the coefficients in series. Beyond this it does not seem necessary to attend particularly to the terms which Professor Gyldén has designated as critical.

To give a succinct idea of the scope of this method, it may be said that it is applicable whenever, in the system, the planets maintain their order of succession from the Sun. In systems where that undergoes change, as is the case with the group of minor planets, supposing their action on each other is sensible, it is not applicable.

Delaunay's method has not yet received all the developments and applications it is susceptible of.

The treatise of Hansen on the shortest and most ready method of deriving the perturbations of the small planets was published in the interval 1857–1861. But as the principles on which it is founded had been elaborated and communicated to the public some years earlier, it is, perhaps, more properly to be assigned to the first half of the century. In consequence, I pass it over with this slight mention.

Perhaps the most conspicuous labours in our subject, during the period of time we consider, are those of Professor Gyldén and M. Poincaré. We will limit our attention, for the remainder of this discourse, to the consideration of these investigations.

G. W. Hill.

[To be continued.]

The Spots in Jupiter's N. Hemisphere.

In a note in the 'Observatory' for Aug., p. 316, referring to Dr. Rambaut's paper on the "garnet" spot on Jupiter, it is mentioned that "two well-defined dark spots hitherto unobserved" were noticed on the disc of Jupiter last autumn, and that "M. Antoniadi first saw these spots." I believe, however, that the preceding spot of the two, somewhat in the shape of a violin, was observed during the opposition of 1894–5, and that both the "violin" and "garnet" spots were first seen at Bristol in the early autumn of 1895.

On 1894 Nov. 5 I observed a small though conspicuous dark spot on N. edge of great N. equatorial belt of Jupiter, and followed this object until 1895 May 9, as follows:—

	Transit.	Long.
1894 Nov. 5........	10^{h} 57	239°·1
15........	9 10	238 ·2
17........	10 47	237 ·6
29........	10 39	237 ·6
Dec. 4........	9 42	235 ·1
18........	11 14	236 ·5
19........	7 6	237 ·0
31........	6 56	235 ·7
1895 Jan. 26........	8 18	234 ·0
28........	9 56	233 ·8
March 22........	8 41	227 ·9
24........	10 19	227 ·3
April 10........	9 28	227 ·7
15........	8 38	227 ·8
May 2........	7 49	228 ·9
9........	8 34	226 ·3

Mr. Gledhill also saw this spot, and gives its time of transit on 11 dates, between 1894 Nov. 5 and 1895 April 15, in 'Monthly Notices,' 1896 June, page 486. He obtained observations on 5 nights when the spot was also seen at Bristol, and the differences in the transit times only average 0^{m}·7, which is very satisfactory. I found the rotation period 9^{h} 55^{m} 37^{s}·8 (from 447 rotations)*. The spot was very dark before 1895 April, but on the 10th of that month I noted it as "rather faint and much less conspicuous than before." On May 2 and 9 I also noticed it as faint, and it was different in form, being larger than formerly, and elongated in the same direction as the belts.

Now on the morning of September 27, after some hours spent in comet-seeking, I put a power of 312 on my 10-inch reflector and turned it on Jupiter, when I at once saw two very dark and distinct spots in the bright zone outlying the great N. equatorial belt of Jupiter. I roughly estimated their times of transit as follows, on this and two subsequent occasions:—

	Transit.	Long.	Transit.	Long.
1895 Sept. 26	14^{h} 50^{m}	222°·6	16^{h} 45^{m}	292°·7
1896 Feb. 4	7 25	208 ·0	11 36	267 ·2
Feb. 9	6 21	201 ·1	....	
21	......		7 59	264 ·3

I derived rotation periods of 9^{h} 55^{m} 33^{s}·8 and 9^{h} 55^{m} 32^{s}·6 for these objects. Mr. Gledhill obtains periods of 9^{h} 55^{m} 32^{s} ("grey spot") and 9^{h} 55^{m} 33^{s} ("dark spot") for the same markings ('Monthly Notices,' 1896 June, pp. 484-5). The first of these is identical with the "violin" spot, and the second is identical with the "garnet' spot of Antoniadi and Rambaut. The latter derived the period of the garnet spot as $9^{h}\ 55^{m}\ 33^{s}\cdot36$.

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* This object is identical with Prof. Hough's black spot "d," for which he gives a rotation period of 9^{h} 55^{m} 38^{s}·1 for the period from 1894 Oct 30 to 1895 April 9 (see 'Astronomische Nachrichten,' 3354, p. 280).

Now it is highly probable that the dark spot of 1894 and 1895 (to May) is identical with the "violin" spot of the past opposition, for the former on 1895 May 9 had a longitude of $226^{\circ}\cdot3$, decreasing at the rate of about $2^{\circ}\cdot2$ per month *. If this decrease had continued until Sept. 26 following, the longitude of the spot would have been $216^{\circ}\cdot4$, and close to the place of the "violin" spot, which was $222^{\circ}\cdot6$ on same date. If, however, we assume a slower decrease, as we are justified in doing from the rate of motion shown by the spot from 1895 March 22 to May 9, when its longitude varied from $227^{\circ}\cdot9$ to $226^{\circ}\cdot3$ as per the first table given above, then the position of the two objects will be practically identical when errors of observation are allowed for. This question of identity cannot, however, be absolutely settled, for Jupiter was too near to the Sun for the markings to be observed in 1895 June, July, and August.

As to the question of priority in detecting the two conspicuous spots of 1895–6, the matter is not an important one, but it is as well to point out that they were seen here on the night following 1895 Sept. 26, whereas M. Antoniadi at Juvisy does not appear to have noticed them until October 15.

It is to be hoped that these markings will be carefully looked for when Jupiter reappears in the morning sky during the last half of September. Observations of the equatorial white spots are also specially required, to determine whether the retarded motion they exhibited from 1880 to 1887 has been maintained in recent years.

W. F. DENNING.

Bristol, 1896, August 21.

Selenographical Notes.

MARIUS.—There are few objects of its class that will more fully reward careful observation under different phases of illumination than this ring-plain, which is slightly larger than the formation (Manilius) illustrated last month, and more regular in outline, differing little from a circular shape. Its rampart also rises to little more than half the height (4500 feet) above the interior, and is far less brilliant. The annexed drawing was made, under fairly good definition, between $8^{h}\ 35^{m}$ and $9^{h}\ 30^{m}$ on March 25 this year, with a power of 340 on my 8½ reflector, when only the western half of the circumvallation was in sunlight and the craters, ridges, &c. in the neighbourhood under very oblique light. With these conditions prevailing, the visible portion of the ring presents a very noteworthy aspect. The outer western slope, or *glacis*, together with a greater part of the region bordering the terminator, has a very pronounced brownish hue, which could only be fitly represented in a drawing by using a deep shade of sepia. This tone is so evident that I think it would hardly escape the notice of the most casual observer using a moderately high power, as it differs so greatly from the various hues of grey and slaty blue which the lunar surface usually assumes under a low Sun. (A similar appearance may be remarked in connection with the ring-plain Geminus in the 1st Quadrant.) But the most conspicuous feature, which can hardly be overlooked at this phase, is the fine crater-row which extends along the outer slope, terminating on the south near a conspicuous isolated crater. As neither Mädler nor Neison show a trace of these features, so obvious at this phase of sunlight, it must be supposed that they only observed the formation under a higher light. Schmidt draws the crater-row as a valley of varying width, and notes the isolated crater and a smaller one east of it, near the summit of the wall. The latter was not seen on March 25, but has been remarked on other occasions.

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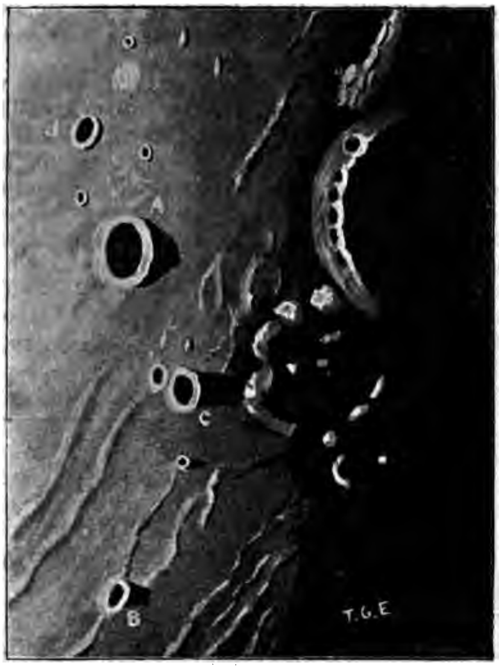
* The probable identity of these objects is also inferred by Mr. Gledhill ('Monthly Notices,' 1896 June, p. 486).



Though Schmidt represents the crater-row as a valley running round the western slope of the wall, it evidently consists of a number of distinct depressions (five were counted) with brilliant rims, as shown in the drawing. As sunrise advances they soon lose their individuality, and assume the aspect of a somewhat coarse groove.

The drawing extends as far north as Marius B (Neison's Map xi.), standing on a prominent ridge, and in a southerly direction, beyond a small crater south-east of Marius *d*. About midway between these objects lies an intensely white circular spot, *x*, with ill-defined borders. It is just faintly indicated on Schmidt's chart, and Neison shows a craterlet, with a short ridge east of it, near the site. It is probably a minute depression, encircled by glittering material, the orifice of which can only be seen under a more vertical Sun.

The arrangement and character of the ridges in the vicinity of Marius are as remarkable as any on the Moon's visible surface. This ring-plain apparently forms the centre at which they congregate most closely, and from which they diverge in undulating lines, extending to a great distance both north and south of it.

A full account of Marius, including a record of all the features recently discovered on the floor and in the neighbourhood Mr. W. H. Maw, F.R.A.S., Mr. Davis, and myself, will be found in the "Selenographical Notes" for February, 1888. The letters on the drawing correspond with those in Neison's 'Moon.'

Beaumont House, Shakespeare Road, T. GWYN ELGER.
Bedford, 1896, August 19.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Eclipses and Chronology: a Reply to Mr. Lynn.

GENTLEMEN,—

In the May number of the 'Observatory' Mr. Lynn has called my attention to the eclipse of the Sun which occurred A.D. 71 March 20, as possibly being the one referred to by Plutarch. I stated in the February number that I had examined all the eclipses which had occurred during the century following A.D. 50, and found only one, namely that of A.D. 118 September 3, which seemed to correspond to Plutarch's description. I have, however, since made a more detailed investigation of the path of the total eclipse of A.D. 71 March 20, with the following results, namely:—

The eclipse was central and total at noon in longitude 22° 44′ east and latitude 48° 16′ north; and if a line be drawn through that point and the city of Naples, it will show the path of the total eclipse. Its magnitude at Chaeronea, the residence of

Plutarch, would not exceed nine and one-half digits, whereas the magnitude of the eclipse of A.D. 118 Sept. 3 at the same place exceeded ten and one-half digits. An easy computation shows that more than two and one-half times as much of the Sun's surface was uncovered in the former eclipse than in the latter; and it is very doubtful if stars could be seen with so much of the Sun uncovered. Besides, the same reasons which forbid us to believe that Plutarch was engaged in writing moral disquisitions at the age of ten or twelve years apply with scarcely diminished force at the age of twenty; and Mr. Lynn's statement that Plutarch's literary days must have been over before the eclipse of A.D. 118 I do not regard as having any force, as his age would then be less than three score years and ten—an age, of all others, most suitable for that kind of employment. I can therefore see no reason for changing my views in regard to the date of the eclipse which was mentioned by Plutarch.

Yours faithfully,

Cleveland, Ohio, 1896, Aug. 8. JOHN N. STOCKWELL.

[The above is part of a letter from Prof. Stockwell continuing his discussion with Mr. Lynn on some points of history connected with ancient eclipses. With a view to economizing space and to closing this discussion, we have shown Prof. Stockwell's letter to Mr. Lynn, and have ventured to briefly summarize the arguments, for and against, we hope without injustice to either party. With reference to the above Mr. Lynn writes:—"It is satisfactory to have the circumstances of this eclipse worked out. Though neither the eclipse of A.D. 71 nor that of A.D. 118 were total in Greece, the latter is shown to have been the largest there. It seems probable that Plutarch did reach seventy years of age or nearly so, and was able to take part in philosophical discussions then. Perhaps some doubt may yet remain, as the interlocutor Lucius, who speaks of the stars appearing during the eclipse of the previous year, may have been at the time in Italy or elsewhere on the line of totality. But we may safely reject Mr. King's note in his translation of Plutarch's treatise, that the eclipse was the one of April 30, A.D. 59, when the writer was a mere child."

In the latter part of his letter, which we have not given, Prof. Stockwell recurs to the point under discussion as to whether the eclipse of A.D. 393 Sept. 6 took place during the battle between Eugenius and Theodosius the Great. He repeats that this is stated not only by the historian Zosimus but also by Ammianus Marcellinus and by Prosperus Aquitanus; Mr. Lynn has denied this ('Observatory,' June), because, he says, Ammianus Marcellinus probably died in A.D. 380, and assumes that Prof. Stockwell refers to Marcellinus Comes, a later and inferior writer. Prof. Stockwell now quotes Anthon's classical dictionary to show that Ammianus Marcellinus and Marcellinus Comes were the same person and that the date of his death is unknown. Mr. Lynn says:—"The history of Ammianus terminates with the death of Valens in A.D. 378; but as there occurs a passage in the body of the work in which, speaking of Neothenus, he is called *notavium postea consulem*, and his consulship did not occur until A.D. 390, it is commonly thought that Ammianus survived until the latter year. But the last two words look very like a marginal note which has crept into the text; the historian refers to no other event later than A.D. 380, so that he probably died either in that year or the following.' Anthon says in his dictionary that there is reason for thinking that Ammianus Marcellinus was invested in the latter part of his life with the dignity of *Comes rei privatæ*, but he was certainly not the writer called Marcellinus Comes who wrote the Chronicon in which the eclipse is mentioned, for that extends in its original form (it was added to by others) from A.D. 379 to A.D. 518, and Prof. Stockwell would scarcely extend the longevity of Ammianus to the latter date."

On Mr. Lynn's remark that September 6 was a "more likely season" for a battle than November, Prof. Stockwell says that he thinks the most likely time for a battle to occur at a given place would be when the opposing armies were able to meet at the place, and points out that the army of Theodosius was at Adrianople on June 15; and he considers that this army could not have reached Aquileia, near which the battle was fought (a journey of 800 English miles on a great circle), by Sept. 6, basing this conclusion on the circumstances of Napoleon's march from Dresden to Moscow (1000 miles in 110 days over smooth ground), and from analogy concludes that the battle could not have happened until October at earliest. To this Mr. Lynn replies that Napoleon had a larger force, and stopped on his journey for political reasons, besides being opposed during the latter part of it, which Theodosius was not. We fear that this discussion is now going considerably outside the region of astronomy, and while thanking both these gentlemen for their interesting communications, feel that the time has come to bring this to a close.—EDS.]

Early Observations of the Solar Corona.

GENTLEMEN,—

Our thoughts at the present time are perforce so much directed to solar eclipses, and particularly to the corona, that some further discussion of its first perception as a distinct phenomenon may not be out of place. The earliest record of this is undoubtedly that of Plutarch, which has been already referred to in the 'Observatory,' and I have nothing to add to what I have already said on the subject. He does not mention any particular eclipse, but speaks of an effulgence seen round the circumference of the Sun on those occasions, having probably specially in view that of A.D. 71. But it is commonly said that Clavius, of calendar-reformation celebrity, was the first to describe an appearance, due in fact to the corona, in reference to an eclipse, the date of which is specifically mentioned, viz. that of April 9, 1567. His account is to be found in the fourth chapter of his 'Commentarium in Sphæram Ioannis de Sacro Bosco,' where he tells us that he had observed two eclipses of the Sun, the first in 1560 and the second in 1567. The former (which took place on the 21st of August) was seen by him at Coimbra, in Portugal, and the darkness, according to him, was greater than that of night, the stars appearing in all directions and the birds falling to the earth. The other eclipse, the one to which we are now specially alluding, occurred on the 9th of April, 1567, and was observed by Clavius at Rome about midday. "In quâ," he says, "rursus Luna, etsi inter visum ac Solem interjiciebatur, non totum tamen Solem obscurabat, ut in priori, sed (quod nunquam fortassis alias evenit) relinquebatur in Sole circulus quidam exilis undique totam Lunam ambiens."

Now anyone reading the above would at once conclude that the former was an account of a total eclipse of comparatively long duration and the latter of an annular eclipse. Clavius, in fact, goes on to remark that the difference arises from the different distances of the Moon on the two occasions. Kepler, however, believing that the eclipse on that occasion must have been total, suggested that this "circulus exilis" of surrounding light was either a part of the thicker ether heated by contact with the Sun, or simply an effect of his rays refracted in an atmosphere surrounding the Moon. Albert Curtz, however, who, under the assumed name of Lucius Barrettus, edited the 'Historia Cœlestis,' formed from the observations of Tycho Brahé, gives his opinion (in the Liber Prolegomenos to that work) that the eclipse, as observed by Clavius, was really annular; and so it appears really to have been—very nearly, but not quite, total. Kepler thought it had been total because the Moon was about midway between apogee and perigee and the Sun drawing towards apogee. The circumstances were in fact nearly the same as those in the eclipse of April 5, 1894 which was annular. Tycho (then a young man) observed the eclipse of 1567 at Rostock, where it was a large partial one; also Moestlin at Tübingen.

The eclipse, however, of the 25th of February (Mar. 7, N.S.), 1598, was total for a very short time; and in this Jessenius, who observed it at Torgau, noticed at the greatest obscuration a bright line shining round the Sun, which must have proceeded from the corona. The eclipse was large and partial in England.

An eclipse also occurred on the 12th of October (N.S.), 1605, which was total for a brief interval at Naples. It is supposed to be the eclipse (preceded as it was a fortnight before by a large partial eclipse of the Moon) which is alluded to in the last scene of 'Othello.' Kepler ('De Stellâ Novâ in pede Serpentarii,' p. 116) describes the appearance at Naples:—"accuratè tectum fuisse totum Solem, quod quidem non diu duraverit; in medio, ubi Luna, fuisse speciem quasi nigræ nubis, circumcirca rubentem et flammeum splendorem, æqualis undique latitudinis, qui bonam cœli partem occupaverit."

We must now pass on to the eclipse of March 29 (April 8, N.S.), 1652, which is described by Wing in his 'Astronomia Britannica,' as observed by Dr. Wybord at Carrickfergus in the north of Ireland. Here we first have the expression "corona" applied to the appearance surrounding the Sun; literally because he writes in Latin. The exact words may now be of interest; a translation is given in Grant's 'History of Physical Astronomy,' p. 378. Wybord says:—"Luna momento quasi et ex improvisò, totam se intra Disci Solis orbitam seu ambitum (quatenus conspectui nostro appareret) tam agiliter injiciebat, ut *circumagere aut circumvolvere videretur*, sicut Catillus seu *Lapis Molaris superior* (Cursor dictus) Sole tunc circumcirca ejus limbum seu marginem splendidulo vel corusco apparente, ut esset quasi *Spectaculum Rotationis* dictum, aspectu sanè valde jucundum ac notatu dignum, et quidem æqualiter undique post unum temporis minutum (tamquam conjectare poteram) circiter dimidium digiti aut ⅓ saltem (quantùm etiam conjicere licebat) instar circuli luciduli, vel Coronæ subrutilæ, et tunc pro certo centraliter conjuncta erant *Luminaria* quoad apparentiam."

No other eclipses of special interest occurred until those of 1706 and 1715, with which began the scientific study of the solar surroundings.

Yours faithfully,

Blackheath, 1896, Aug. 12. W. T. LYNN.

P.S.—I should like to avail myself of this opportunity of correcting an error in my letter last month on the Comet of 1647 (p. 304). At line 16 the parenthesis should end with the word "afterwards," and the words from "under" to "Manilius" (inadvertently repeated from three lines above) be omitted. Also in the letter in the July number on the Zodiacal Light, p. 275, line 7 from bottom, the words "of the black spot near Cygnus or" should be omitted, as they belong to the next line, where they stand again. —W. T. L.

Ceremonial in India at the time of Eclipses.

GENTLEMEN,—

The necessity for holidays amongst Hindus in connection with eclipses, whether solar or lunar, depends not so much on the ceremonies which have to be performed as on the strict fast that has to be kept by all orthodox Hindus before and during the eclipse.

The rule, I am told, is that the fast both from food and drink begins three full jaumams for a lunar and four for a solar eclipse before the eclipse begins and continues till the eclipse ends. A jaumam is, roughly, 3 hours, so that the minimum fast is 9 hours *plus* the duration of the eclipse, and, naturally, everyone wants to have a good meal immediately before the time of fasting begins.

In cases in which the Moon sets eclipsed, the fast continues till the Moon rises again. The Government rule is that a holiday is given only when the eclipse takes place between 6 A.M. and 6 P.M., but this by no means meets the necessities of the case. In the case referred to in "From an Oxford Note-Book," the rising of the High Court in the forenoon on account of an eclipse that was not to take place till 10 P.M. was justified by the consideration that no orthodox Hindu could touch food or even water after 1 P.M. till the eclipse was over.

Yours faithfully,
C. MICHIE SMITH.

The Observatory, Madras,
1896, July 29.

OBSERVATORIES.

ROYAL OBSERVATORY, CAPE OF GOOD HOPE.—The principal feature of the work of this observatory during the year 1895 was, it is stated in the Report just to hand, the progress which was made in clearing off arrears of reduction and publication. It will be seen from the list given below, which is abridged from that in the Report (no doubt we shall have opportunity to give the full titles of the works later), what a sweeping clearance has been made in preparation for the astro-physical work which will be begun shortly, thanks to Mr. McClean's generosity. The publications referred to are as follows:—

The Cape Catalogue for 1885 was distributed.

The Annual Results of Meridian Observations for 1885, 1886, 1887 were distributed, those for 1888, 1889, 1890 were passed through press, and those for 1892, 1893, 1894 are in the hands of the printer.

The printing of the work on the Determination of Solar Parallax from Minor Planet observations is nearly completed.

The first volume of the Cape Photographic Southern Durchmusterung, containing the stars from Declination −19° to −37°, has been passed through press. The MS. of the second volume, containing the stars from Declination −38° to −52°, is ready for press.

The account of the Geodetic Survey of South Africa has, with the exception of the Index and Index-maps, been passed through press. The report of this work is ready for presentation to the Colonial Parliament.

All this work of printing and publication has necessarily not been done without some sacrifice of work in other directions, and the policy of limiting the observations, which was begun in 1892, had to be continued in 1895. The chief observing work has been with the Transit-Circle, with which observations for a new circumpolar catalogue have been made. The number of these during the year—Transits 2872, Declinations 2240—was comparatively small, owing to the fact that circumpolar stars take longer to observe, as they move slowly. We are sorry that Dr. Gill has been obliged to cut off his programme the meridian observation of the Sun, which, while not requiring a great effort, leads to results of considerable interest.

The Equatorial work during 1895 was confined to a few observations of occultations of stars by the Moon, and to searching for Comets Brooks and Perrine. The latter was seen once.

As to the Astrographic work, 91 plates were taken for the Catalogue; of these, 55 were passed as successful. This brings the number of "Catalogue" plates taken to 1497, which leaves only 15 to complete the whole number. 367 plates were taken for the Chart, of which 240 were considered as successful, which brings the whole number taken to 503.

Thirty-four "Catalogue" plates, containing 2557 stars, have been completely measured each by two observers, and an investigation of the sinuosity of the lines of a réseau has been made by Dr. Gill and Prof. Jacoby, which will shortly be published.

Dr. Gill again refers to the insufficiency of the staff; and after reading the above *résumé* of the work for the year, it must be obvious to everyone that its members, which are only four assistants and under a dozen (on the average) supernumeraries, well deserve the expression of thanks that the Director accords them. The acquisition of the new M^cClean Telescope and the proposed Astrophysical department certainly necessitate more help.

In the paragraphs relating to Time-signals, we are surprised to find no reference to the adoption of "Cape Uniform Time" which was mentioned in the Report of the Natal Observatory.

MADRAS.—The Report prepared by the Director of this Observatory for presentation to the Indian Observatories Committee, covering the twelve months ending 1896 March 31, is a little lacking in interest. Prof. Michie Smith has been engaged to a great extent in the establishment of the Observatory at Kodaikanal (it may be remembered that he was in England last year on this business), and we are sorry to see from the Report that this institution is not proceeding so rapidly as Prof. Michie Smith would wish. The chief astronomical work mentioned is the determination of the divisions errors of the meridian circle, which is being made with the new steel micrometer-screws made for this instrument by Messrs. Troughton and Simms last autumn. As a specimen of this work there is given the corrections to the four quadrants, determined by each of the three observers, which are in good agreement, the greatest difference from the mean being about 0″·2.

The preparation of the Madras Catalogue for epoch 1875·0 is being pressed on, but the Director does not express himself as being well satisfied with this prospective publication, especially as regards the polar distances. The only other astronomical work of the year was the observation of star transits for clock-error, necessary for the time-distribution service, which has continued with satisfactory regularity. The meteorological records have been maintained in the usual form, and all reductions have been kept up to date.

The state of things at Kodaikanal, referred to above, will be understood from the following paragraph, which has been communicated to the Public Works Department:—

"The work at Kodaikanal has been greatly delayed for reasons which it is not easy to understand, and by the close of the year nothing had been done beyond the making of a road and the collection of some material. In October, indeed, his Excellency the Governor laid the foundation-stone of the new Observatory, and it was hoped that this indicated an intention to proceed with the work; but this hope has not been justified by the result. At the present rate of progress it will be many years before the Observatory is ready for the instruments."

YALE.—For several years the name chiefly associated with the observatory attached to Yale University has been that of Dr. Elkin. But, though he has been spoken of as the Director, actually his official title has been merely "Astronomer in charge of the Heliometer," and as such he has reported annually on the work done with this instrument to a Board of Managers; Mr. Brown, the Secretary, making a similar report on other observatory matters. Now, however, we learn that Dr. Elkin has been recently appointed to the newly revived post of Director of this Observatory.

The Secretary's report for the year ending 1896 May 31 deals almost entirely with matters relating to building and library. Dr. Elkin's report is not too long to give *in extenso*. Dr. Chase's work on the star-cluster was written of in our last number.

"The series of measures for the purpose of detecting possible large parallaxes of stars with large proper motion has been carried on during the past year by Dr. Chase and myself. A few stars have been added to the list to fill up the gaps which presented themselves in the course of observing. As at present planned, the work will be completed probably in the course of 1897, as far as the observations are concerned.

"The series of the parallaxes of the first magnitude stars is, as stated in my last report, practically brought to a close, and only a few points of discussion remain to be revised.

"A considerable portion of my time has been devoted to a final revision of the discussion of the work on Iris as it passed through the press. This has now been accomplished, and the work will shortly appear as Part IV. of the work issued by Dr. Gill on the determination of the Solar Parallax by Heliometer measures of Asteroids.

"Dr. Chase has passed through the press his work on the relative places of the principal stars in the cluster in Coma Berenices, and it is ready for issue as Part V. of our Transactions.

"I regret to say that we were not successful in the past season in securing photographic records of meteor trails. The apparatus was put in use during several nights of the August showers, but no meteors appeared of sufficient brilliancy to impress themselves on the plates, which had necessarily become somewhat fogged by the strong moonlight. We were equally unfortunate in our attempts on the Leonids and Geminids in November and December, respectively. During this year we have had only two lenses in use, as no further ones of sufficient size and quality were to be found in the market. It seems wise, however, in view of the favorable chances for the Perseids this year, and the approaching maximum of the Leonids, to make an especial effort to secure a complete battery for our mounting as originally planned."

THE following notes on the work of some European observatories during 1895 are abridged, similarly to notes in previous years, from the reports in the 'Vierteljahrschrift der Astronomische Gesellschaft.'

BAMBERG. *Ernst Hartwig.*—The heliometer was used for measuring the Sun's diameter on 20 days and the diameter of Venus on 6 days. Observations were obtained of Comets Swift, Perrine, and Perrine-Lamp, and of the variables Z Cygni, W Cygni, and T Draconis. The positions of Venus, Mösting A, and the dark spot on Jupiter were also determined on several occasions with the same instrument. With the refractor 850 comparison measures of variables were made on 65 nights.

The large refractor was used for spectroscopic observations of coloured stars, and these results were published in Ast. Nach., Nos. 3303 and 3328. Amongst the photographic work may be mentioned the endeavours to determine by this method the radiant of the Perseids in August 1895. The transit was used for time-determination and for longitude work.

BERLIN. *W. Foerster.*—With the large Transit-Circle, Dr. Battermann secured 1506 observations of stars in R.A. and 1165 in zenith-distance from a working catalogue, including Moon culminators, some stars selected from the southern zone allotted to Berlin of the Astr. Gesell. catalogue, comet comparison-stars, and about 200 faint stars in Rümker's catalogue. These are reduced. In the course of the reduction of stars observed for latitude, Dr. Battermann finds that the mean error of a single observation is $\pm 0''\cdot360$, using 954 observations of 216 stars, and $\pm 0''\cdot270$, using 416 observations of 53 fundamental stars. From the observations made in 1891–92 with the Universal Transit, a value of the Aberration Constant $20''\cdot511 \pm 0''\cdot016$ (mean error) was deduced. Systematic observation of occultations was commenced in 1895 with the 6-inch refractor, and attended with fair success. With the 9-inch Dr. Knorre and Dr. Tetens made a few measures of double stars with the filar micrometer and a larger number with the double-image micrometer. Time-service.

BONN. *F. Küstner.*—The regular work has not been changed. Some 5000 complete observations of stars were made as a contribution to the projected catalogue. Work on zone stars +48° to +50°.

BRESLAU. *J. G. Galle.*—Very little astronomical work has been done here, and the magnetic and meteorological work has somewhat diminished.

DRESDEN. *Dr. B. von Engelhårdt.*—The observation of Bradley wide pairs with the 12-inch Grubb equatorial has been completed, and observations secured of planets Themis and Diana, and also of Comets Perrine and Brooks (1895 Nov. 21). Time-service.

DÜSSELDORF. *R. Luther.*—As in previous years, the ring-micrometer attached to the 7-ft. refractor was in constant use for observing small planets, 87 measures being obtained of 25 planets, making, since 1847, in all 1879 observations of 195 planets.

GENEVA. *R. Gautier.*—Latitude observations. The Plantamour 12-inch equatorial has been used by M. Kammermann for celestial photography, more especially for lunar work. The two lunar eclipses of March 10 and August 3 were observed under favourable conditions. During the year 396 watches were tested. Meteorology. Time-service.

GÖTTINGEN. *Wilhelm Schur.*—Dr. Schur, with the heliometer, measured the polar equatorial diameters of the Sun on 13 days; continued his Triangulation of the clusters h and χ Persei; measured Jupiter's diameter at time of quadrature in March and October, and various other work. Dr. Ambronn also used the heliometer, and made measures of the solar diameter on 13 days and measures for triangulation of stars near the pole. The small Fraunhofer heliometer was employed for measuring wide Σ pairs. Transit work. It appears that Miss Chisholm of London and Miss Winston of North-America are working at this Observatory.

HAMBURG. *G. Rümker.*—Zone work 80° and 81° North Dec. Observations of nebulæ and of comets 1895 II. (Swift), 1895 IV. (Perrine), and of small planets. Observations of variable stars. Chronometer work for the Imperial Navy. Time-service.

HEIDELBERG. *Max Wolf.*—Time-service; Longitude work. Drawings of the surface of Mars, Saturn, and Jupiter with the 6-inch equatorial. Photographs of nebulæ and small planets. The estimation of magnitudes of the fixed stars by photography was also continued.

[To be continued.]

PUBLICATIONS.

Dr. Auwers' Zone Catalogue.—Towards the great catalogue of the 'Astronomische Gesellschaft' the Berlin Observatory undertook to contribute the zones between 14° 50′ and 25° 10′ N. Dec. Dr. Förster invited Dr. Auwers to take part in this work, and it was thought expedient to divide the zone into two halves, the southern half being assigned to Dr. Auwers. He obtained the assistance of Dr. Romberg, who read the circle, while Dr. Auwers made the observations. The instrument at their disposal was the old transit-circle of the Berlin Observatory by Pistor and Martins, which was erected in 1837, of 4 inches aperture and 5 feet focal length, with a circle of three feet diameter, divided to every two minutes of arc. With this somewhat old instrument they began the ambitious task of observing nearly 10,000 stars by eye and ear, but soon added to their instrumental equipment a chronograph, which was kept in a different room and needed frequent winding, and now and then did not register. In addition to this the weather was no kinder to Dr. Auwers and Dr. Romberg than it is to less distinguished astronomers, and frequently cleared when they had given up thoughts of work for the evening and gone home (one kilometre from the Observatory), or else clouded as soon as they had opened the shutters. Nevertheless, between 1869 February and 1871 August, they finished their zone, making 22,028 observations of 9789 stars, exclusive of 2822 observations of fundamental stars and polars, each star being observed at least once in each position of the instrument.

The stars observed consisted, according to the programme of the Astron. Gesellschaft, of all the stars of the Bonn Durchmusterung of the 9th magnitude and brighter, and in addition to these the fainter stars which the letters in the B. D. indicate as having been observed by Bessel, Struve, &c.

Working lists of stars were prepared, usually consisting of stars not varying more than 1° in declination, and containing, on the average, 66 zone stars, 7·2 fundamental stars, and 1·1 polars. One or two, occasionally three, zones were observed on the same evening, the time taken being from 60 to 80 minutes for each zone, and an interval of about 15 minutes being allowed between two zones. In order to accelerate the observing, the dangerous expedient was adopted of reading only one microscope and applying a correction determined for each division of the circle in the zones to reduce this reading to the mean of the four. This correction was applied, together with the division error belonging to the reading of the mean of the four microscopes.

The zero of the circle or equator point was first obtained approximately by comparison with the declinations of the fundamental catalogue, the simple mean deduced from all the stars being used. This was corrected for its change during the zone, as it was found that the change was usually in the same direction.

Apparent corrections were then deduced to the declinations of the fundamental catalogue, and the mean of these corrections for each star (at least five observations being used) were applied to the declinations of the fundamental catalogue, and a second approximation to the equator point deduced. The resulting apparent corrections of the fundamental catalogue were again deduced, and these values used in obtaining a third and definitive equator-point. With these corrections to the equator-point the observations were completely reduced, and the mean places for 1875·0 determined.

Comparison between the observed Declinations in the two positions of the instrument were now made, and the mean difference was found between the observations in each of the 231 zones and of the same stars in other zones. Further, the differences were formed for each separate degree of declination, and found to be in

Zone 15°	+0″·047	from	1530	stars.
16	+0 ·157	„	1440	„
17	−0 ·150	„	1411	„
18	−0 ·560	„	1552	„
19	−0 ·279	„	1529	„

As these numbers agree fairly closely with the means of the differences of the corrections applied in the E. and W. positions of the circle for division error and the reduction of the readings of one microscope to the mean of four, the conclusion was reached that these should not have been applied.

From discussion of the mean differences obtained for each of the 231 zones, as well as the general difference for each degree in the two positions of the instrument, corrections were deduced applicable to the single zones. The following table, copied for the first 10 zones in the regular series of observations, will give an idea of the magnitudes of these quantities:—

	Correction to Decl.	No. of Stars.
Circle East	−0″·08	104
„	−0 ·84	110
„	−0 ·01	44
Circle West........	+0 ·11	145
„	+0 ·45	92
„	+0 ·26	60
„	+0 ·62	13
„	+0 ·39	66
„	+0 ·33	122
„	−0 ·24	52

Along with this correction to the separate zones was applied a further supplementary correction, whose general effect was to annul the previously applied erroneous division error; and as it would have been too troublesome to revise the original computations, a table was formed for this purpose, whose argument was the apparent declination. A similar method of reduction was adopted for the right ascensions, and the only point of interest peculiar to this is the following correction, varying with the magnitude of the star, which was applied for personality:—

To mag. 8·8	0		
For mag. 8·9....	$-0^s.009$	9·3....	$-0^s.058$
9·0....	-0.020	9·4....	-0.073
9·1....	-0.031	9·5....	-0.089
9·2....	-0.044	9·6....	-0.106

It is rather difficult to trace the effect of the different corrections used without the actual numbers, but unless Dr. Auwers' methods have not been correctly followed, it would seem that the erroneous corrections for reduction of the single microscope to the mean of four might have considerable effect on the special corrections determined for each separate zone, and that the subsequent subtraction of this erroneous quantity is not applied till its effect has been partly counteracted in other ways.

Of the extensive comparisons which Dr. Auwers makes between this catalogue and others, mention here need only be made of those comparisons which are used to determine the systematic and accidental errors of Dr. Auwers' catalogue. The catalogues made use of for this purpose are the Pulkova Catalogue of 1855; Romberg's Catalogue of 1875; the 7-year, 9-year, and 10-year Greenwich Catalogues; the later Berlin Observations, of Küstner and Battermann, with the new meridian circle; the overlapping band of the adjoining zone, 20°–25°, observed by Becker.

From these comparisons he deduces a correction of $-0''.16$ to the declinations of his catalogue, in order to made it agree with the Ast. Ges. Fund. Cat., and finds that the excesses of the errors in the separate zones of 10' over the mean errors of each whole degree are as follows:—

	0'	10'	20'	30'	40'	50'	60'
15°......	$+0''.26$	$+0''.11$	$+0''.10$	$-0''.32$	$-0''.30$	$+0''.14$	
16	0 ·12	0 ·01	0 ·22	0 ·19	0 ·07	−0 ·08	
17	0 ·22	0 ·34	0 ·30	0 ·21	0 ·47	0 ·19	
18	−0 ·09	0 ·13	0 ·18	0 ·01	0 ·20	0 ·02	
19	+0 ·16	0 ·21	0 ·27	0 ·28	0 ·24	0 ·12	
	+0 ·13	+0 ·16	+0 ·27	−0 ·20	−0 ·26	−0 ·05	
		$+0''.17$			$-0''.17$		

It appears that there was periodicity in the errors of the 2' divisions of the separate degrees, and Dr. Auwers remarks that this would not have been eliminated by the reading of more microscopes. A table of corrections is given for every 2' to reduce the declinations of the Catalogue to the system of the Ast. Ges. Cat. The quantities in this table vary from $+0''.49$ to $-0''.66$.

From a comparison with the Pulkova catalogues and later Berlin catalogues, a correction to the right ascensions for each hour is deduced. The means of these corrections are—

0^{h}–6^{h}	6^{h}–12^{h}	12^{h}–18^{h}	18^{h}–24^{h}
$+0^{\mathrm{s}}{\cdot}017$	$-0^{\mathrm{s}}{\cdot}007$	$-0^{\mathrm{s}}{\cdot}015$	$+0^{\mathrm{s}}{\cdot}006$

but the Greenwich catalogues do not support this.

The accidental error of the declinations of this catalogue is somewhat larger than those of Dr. Becker's 'Catalogue of the Northern Berlin Zones.' In the neighbourhood of declination 20°, Dr. Auwers concludes that the mean accidental errors (errors of mean square) of both these catalogues, as well as of the Pulkova and Greenwich catalogues, are as follows:—

Pulkova and Greenwich	$\pm 0^{\mathrm{s}}{\cdot}035$	$\pm 0''{\cdot}37$
Zone Catalogue of Becker (20°–25°)	$0{\cdot}035$	$0{\cdot}51$
Zone Catalogue of Auwers (15°–20°)	$0{\cdot}035$	$0{\cdot}65$

Of the exhaustive comparisons with other catalogues which Dr. Auwers has made, and the determination of a large number of proper motions, I hope to give a brief account in the next number of the 'Observatory.' F. W. Dyson.

Annals of the Harvard College Observatory, Vol. XXXIV. Southern Photometry.—Of all the instruments in use at Harvard Observatory, and there are many of them, there is not one whose name is so particularly associated with that of the institution as the Meridian Photometer. Harvard is, we believe, the only institution which uses a photometer exactly of this form, and the account of the work done with it has formed an item in the Director's annual report for many years. The latest volume from Harvard, No. xxxiv., is devoted to the work done with this instrument in South America by Prof. Solon I. Bailey, which completes the determination of the magnitude of all the stars in the sky of the sixth magnitude and brighter, from the north to the south pole.

As distinguished from other forms, the principle of the meridian photometer is that the light of the star under examination is compared with that from some other star taken as standard. To effect this, two object-glasses are placed side by side, with a plane reflector in front of each. A double-image prism near the eyepiece, and at a distance from the object-glasses nearly equal to their focal length, separates the light received from each into two pencils. The pencil of ordinary rays from one object-glass is made to coincide with that of extraordinary rays from the other, and the two remaining pencils are excluded from the field by the eye-stop. A Nicol, protected by a thin glass cover between the eyepiece and the eye, is rotated by the observer, and its position, when the images to be compared appear equal, is read from a graduated circle. The axis of the instrument is perpendicular to the plane of the meridian, and the reflectors can be turned so that any star may be compared, about the time of its culmination, with some star near the pole, selected as a standard of reference.

The first meridian photometer used at Harvard had object-glasses each of 4 centimetres aperture and of 80 centimetres focal length. With this instrument the magnitudes of all the stars as faint as the sixth magnitude in the northern hemisphere as far south as declination −30° were determined, and the results were published in Volume xiv. of the Harvard College Annals, the catalogue contained in which is well known under the title "Harvard Photometry." A larger instrument of the same pattern, with objectives each of 10·5 cm. aperture and of focal length 166 cm. and 145 cm. respectively, was set up in 1882 and used to continue the work, so as to include stars down to magnitude 9·5 and to revise the results of Vol. xiv. This was finished in 1888, and this instrument has since been in the charge of Prof. S. I. Bailey, who has set it up in various places in South America to extend this photometric survey to the south pole. The volume now before us gives as the result of his work the determination of the magnitude of 7922 stars between declination −30° and the south pole, of all magnitudes down to 9·5, and also a catalogue giving the approximate places and magnitudes of all the stars in this region which are considered by various authorities of the 6th magnitude or brighter, completing thereby the "Harvard Photometry" for the whole sky.

The first chapter is an historical account of Prof. Bailey's travels in South America, giving, with some detail, the incidents (often of an unpleasant nature) of the life of himself and family during the two years over which the mission extended. The place first chosen for the observatory was on a peak of the Andes, afterwards known as Mount Harvard, near Chosica (lat. 11° 51′ S., long. $5^h\ 7^m$ W.), and here the Professor and his family dwelt in much isolation from May to November 1889. The approach of the cloudy season made it desirable to change quarters, and the instrument was moved to Pampa Central, near Antofagasta (lat. 23° 10′ S., long. $6^h\ 38^m$ W.), where observations were made in January and February 1890. Prof. Bailey returned to Mount Harvard for the summer months, and for the winter of 1890–91 moved to Arequipa (lat. 16° 24′ S., long. $4^h\ 43^m$ W.), which had by that time been decided on by the Harvard College authorities as the permanent location of the southern branch of the Harvard College Observatory. Prof. Bailey observed here until 1891 May, when he took the meridian photometer back to Harvard, leaving the rest of his instrumental equipment in the charge of Prof. W. H. Pickering.

As has been said above, the essential principle of the meridian photometer is the comparison of the magnitude of the star with some standard star. The star chosen was the close southern circumpolar σ Octantis; but as it was possible that, owing to difference of atmospheric absorption consequent on the change of zenith distance, the apparent brightness of this star might not be constant, this star was compared on each night with ten or more stars of the Harvard Photometry, from which corrections were deduced to apply to the night's observations. The scale of magnitude is therefore essentially that of the northern survey.

There is little to be said of the chapter on the reduction of observations. An observation is sufficiently complete when two circle readings have been made, which show the position of the Nicol prism when the image of the star under observation formed by the extraordinary ray is equal in brightness to that of the comparison star formed by the ordinary ray and *vice versa*, and the reduction is effected by taking the difference of these readings. But to eliminate possible error due to polarization at the reflectors, the operation is repeated with the double-image prism rotated through 180°. The only correction necessary seems to be that for atmospheric absorption, which depends on the length of the path in air traversed by the light and the condition of the air. This last, defined by a quantity known as the coefficient of absorption, is determined for each night by comparison of the observed brightness of stars of the Harvard Photometry with their magnitudes there given, or in the case of southern stars of the observed brightness of σ Octantis, with its adopted magnitude.

Chapters IV. and VI. give the tabulated results of this work. Chapter IV. is a catalogue known as the Southern Meridian Photometry, giving the photometric measures of 7922 stars of all magnitudes down to the tenth, the stars being selected from the Argentine General Catalogue or the Cordoba Zone Catalogue. The magnitudes as given in these works are printed in parallel columns with those observed. The second of these chapters is a catalogue to be known as the S.H.P. (Southern Harvard Photometry), which gives the photometric magnitudes of 1428 southern stars, with their approximate positions for 1900·0. These are the stars of the sixth magnitude and brighter, collected from the list just mentioned and arranged in order of R.A., with columns giving for each star the name of its constellation, reference numbers to various catalogues, and its magnitude as given in Behrmann's 'Atlas,' Houzeau's 'Uranometria General,' and the A.G.C., as well as the present observed magnitude.

It would be impossible to make any definite remark as to the accuracy and value of the results without extensive comparison with similar results, and such an investigation must be left to the future; but one cannot but be struck with the zeal of Prof. Bailey, who has accumulated such a quantity of observations in so comparatively short a time and at the sacrifice of much personal comfort. The first Harvard Photometry was justly considered as marking a distinct advance in astronomical science, being the first attempt to make on a large scale a scientific determination of stellar magnitudes, and this, which extends the preceding work to the limits of the whole heavens, is no less remarkable.

NOTES.

Comet Notes.—The following ephemeris of Brooks' Comet (1889 V.) by Herr Bauschinger is for Berlin midnight:—

	R.A. h m s	S. Dec. ° ′		R.A. h m s	S. Dec. ° ′
Sept. 4....	22 18 10	19 5	Sept. 20....	22 9 51	18 22
8....	22 15 38	18 59	24....	22 8 45	18 3
12....	22 13 21	18 50	28....	22 8 8	17 41
16....	22 11 24	18 38	Oct. 2....	22 8 1	17 16

The brightness is at its maximum, twice that at time of discovery, throughout nearly all the month.

This comet was observed at Strasburg on August 11, the observation showing corrections to the above ephemeris, $-0^{s}\cdot49$, $-0''\cdot7$. It is said to be faint, about $0''\cdot5$ in diameter, round, with slight central condensation.

Mr. Chas. Lane Poor gives the following elements of this comet, corrected by the aid of M. Javelle's observation on June 20 (Ast. Journ. 380):—

Epoch 1896 Oct. 23·5 G.M.T.

π	1° 48′ 54″	1896·0.
☊	18 1 8	
i	6 3 34	
ω	343 47 46	
log a	0·56736	
log e	9·67159	
log μ	2·69896	
T	1896 Nov. $4^{d}\cdot162$ G.M.T.	

He considers that the identity of this comet with that of Lexell is now practically disproved. A very close appulse to Jupiter took place in 1791, and the orbit must have then suffered great disturbances, the nature of which cannot yet be accurately determined.

Perrine's First Comet (1895 IV.) was still visible with the 36-inch refractor of the Lick Observatory in the middle of July, the brightness being then only about $\frac{1}{70}$ of that at discovery.

A. C. D. C.

Minor Planet Notes.—Herr Groeben, in Ast. Nach. 3372, discusses the motion of (151) Abundantia. He finds some remarkable discrepancies between the observed and computed places, which he explains by supposing that there are two neighbouring planets travelling in almost identical orbits, of which sometimes one has been observed, sometimes the other. He requests observers to endeavour to detect the second planet at the favourable opposition in November next.

The following planets have received permanent numbers:—

Planet.	Date of discovery.	Discoverer.	No.	Planet.	Date of discovery.	Discoverer.	No.
CE ...	1895 Dec. 9.	Charlois.	409	CN ...	1896 Jan. 16.	Charlois.	414
CH ...	1896 Jan. 7.	„	410	CO ...	Feb. 7.	Wolf.	415
CJ ...	Jan. 7.	„	411	CS ...	May 4.	Charlois.	416
CK ...	Jan. 7.	Wolf.	412	CT ...	May 6.	Wolf.	417
CL ...	Jan. 7.	„	413		May 8.	Charlois.	

CM proved to be identical with (332) Siri, while CP, CQ, CR have not been sufficiently observed to receive permanent numbers.

A. C. D. C.

The Total Eclipse of August 9.—The Total Eclipse of the Sun, which was looked forward to as the astronomical event of the year, has proved a bitter disappointment for many persons. As will be seen from Prof. Turner's notes, the observing parties in Japan, after careful consideration of meteorological chances, had distributed themselves, some occupying Akkeshi and others going further north to Esashi.

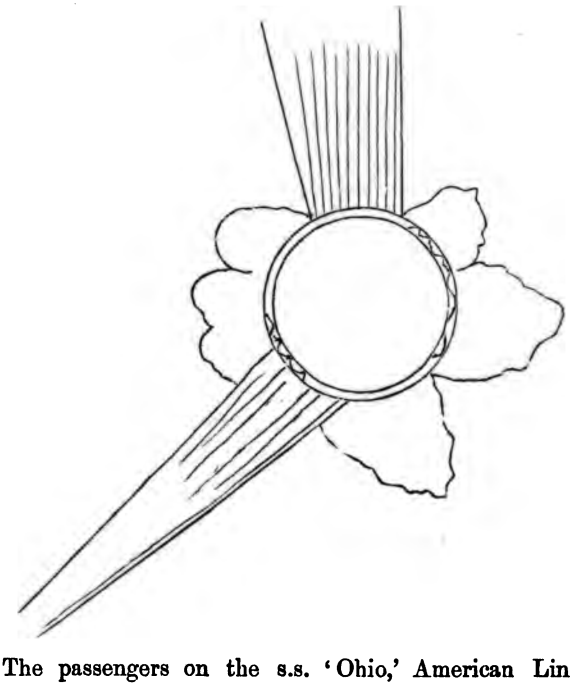
A Reuter's telegram in the daily papers of August 10 reported that it had been clear in Yokohama, but that it was thought that bad weather had prevailed in the northern island. On August 11 we received a telegram from the English expedition announcing "zero" as the result. At present date (August 28) no better news is to hand from Esashi.

At the next station westward, at Orlovski on the Amur, it appears that the Russian party was more fortunate; it is said that the sky was overcast, but that it cleared during totality, so that the corona and several stars of the first magnitude were visible. Prof. Belopolsky and MM. Orbinsky and Vittram were of this party. It is also reported that at Tiumen, in Western Siberia, the sky was clear, and one good photograph taken. At Tornea in Finland and in Nova Zembla Russian astronomers have also been successful. A series of ten photographs was obtained at the former place.

The many observers on the Varanger Fiord were much disappointed. Mr. Maunder, writing on July 31 from Bodö, did not speak very hopefully of weather prospects; and although on the eventful morning the clouds occasionally broke to give a glimpse of the partially eclipsed Sun, during totality the clouds did not allow a feature of the phenomenon to be seen.

Almost the only English observers favoured with good weather were those who went in Sir George Baden-Powell's yacht 'Otaria' to Nova Zembla. This party, although made up almost at the last minute, was, we learn from 'Nature,' fairly well equipped with a prismatic camera of two 3-inch prisms of 60° for spectroscopic purposes, and a telescope of long focal length, with an aperture of 4 inches, for photographing the corona. Both instruments were to be fed with light by a Foucault's siderostat. A good set of observations have been obtained with these. It is also reported that totality was well seen at Bodö and in the north of Sweden, and that satisfactory photographs have been taken at these places. A letter in the 'Times' of Aug. 18, from Mr. John Dover, at Bodö, says:—"The corona to the north-east was about the length of the Sun's diameter and very distinct. On the western edge the corona was about two-thirds the length of the Sun's diameter, while to the south-east it was about half a diameter. To the north the corona was very slight indeed, being about one-tenth of a diameter. On the south-western edge of the Sun appeared a large red spot, which was visible until the totality of the eclipse had quite ceased. A Dutch professor near observed two small spots on the eastern side, but these escaped my notice. I glanced away from my telescope for a moment to see if any stars were visible, and observed Jupiter and Venus. Mercury and Regulus were also seen by others present. The colour of the Moon in front of the Sun seemed of a dull grey, while the corona around the Sun was of a light cream-colour. The sky to north and east appeared of a pale orange-colour, while to the west it was of a light yellow shade."

Mr. Maunder sends us the following letter he has received from Miss Mary Proctor, daughter of the well-known astronomer, with a drawing of the corona as seen at Bodö:—



"The passengers on the s.s. 'Ohio,' American Line, had a splendid view of the total eclipse of the Sun which took place on the morning of August 9th. The sky was cloudless and the atmosphere clear, so that we had a perfect view of the Sun's corona and prominences. The planets Jupiter, Mercury, and Venus were plainly to be seen during totality, and many well-known constellations. The temperature fell two degrees, from 53° to 51°, during totality. We viewed the eclipse from the most favourable position, north-west of the island of Stöt, near the promontory Kunnen, 66° 57′ N., 13° 30′ E.

Data of Eclipse.

h	m	s	
"15	50	22	1st contact.
16	53	25	Total obscuration.
16	55	0	,, ,, ended.
17	50	03	2nd contact.

"s.s. 'Ohio,' Trondhjem,
1896, August 10th."

"Mary Proctor."

In the 'Daily Graphic' of August 27 there is a reproduction of one of the photographs taken at Nova Zembla, which shows a coronal streamer to the North-East (assuming that the orientation of the picture is similar to that of an ordinary map) about a solar diameter in length—a mass extending about three-quarters of a diameter from the limb on the N.W. and the corona from W. to N.E. of breadth about a quarter of a diameter. The polar plumes are distinctly shown. This agrees with Mr. Dover's description, but disagrees with Miss Proctor's as to the position of the long streamer. It would seem from these observations that the corona of 1896 was intermediate between the two Types respectively associated with years of maximum and minimum sun-spots.

Early Observations of Mars, 1896.—Remembering that many of Mr. Percival Lowell's most striking observations of Mars, two years ago, were made several months before Opposition, Herr Leo Brenner this year considered it worth while to begin early. In a letter which he has kindly sent us he states that he attempted observations of the physical features of the planet eleven months before the Opposition which will happen on Dec. 10 next, but did not succeed in getting any result worth recording until April 14. His drawing at this date showed distinctly the Gulfs Aonius and Titanum and the polar cap extending as far as 50° south of the Martian equator. Since that date our correspondent, observing Mars every fine morning, has obtained twenty-five drawings, the salient points of which, as described in his letter, we recapitulate here.

According to Mr. Lowell's theory it was expected that the "seas" would be very pale, Hesperia and the canals invisible; but to Herr Brenner's surprise he saw the seas darkest in April, fainter in May and June, and dark again in July. The peninsula

Phaetontis and the islands Electris and Eridania were invisible in April and May, but Hesperia was seen on June 14.

On April 24 the canal Titan was suspected. The canals Phasis and Eumenides were seen as one curved line on May 18, seven months before opposition and two months before the summer solstice of that hemisphere. Two days later, canals Ganges and Iris were seen as a prolongation of Phasis. On July 2 another canal was seen, and by July 15 eleven canals in all had been identified.

Deucalion, Hellas, Noachis, and Ansonia were first seen on May 5, Lacus Solis on May 19, Argyre I. on May 26, Thyle II. on June 14; but the most striking observation, Herr Brenner says, is that of a new formation which he suspected on July 10, but saw with great distinctness on the 15th, as a peninsula joining Libya with Hellas. Later, when the region was near the central meridian, they more resembled an island, nearly touching Hellas and Libya, but then appeared not so brilliant as when seen nearer the limb. The object was seen again next day, when this faintness near the centre was repeated.

The polar cap dwindled very rapidly, and Herr Brenner hazards the conjecture that all the snow will be melted in perhaps six weeks from date of writing, July 18.

A note in Ast. Nach. 3373 reports that Mr. Lowell saw the canal Ganges double on Aug. 16.

ON ERRORS OF OBSERVED RIGHT ASCENSION DEPENDING ON THE MAGNITUDE OF THE STAR OBSERVED.—It will be remembered that Prof. Newcomb recently published a research on this subject which was noted in our May number. Prof. George Comstock has also been making an investigation of the same point, which has appeared in Vol. IX. of the 'Washburn Observatory Publications,' recently distributed, but the appearance of Prof. Newcomb's paper induced Prof. Comstock to publish his results in advance in 'Ast. Journal,' No. 376.

Prof. Comstock obtains his data thus:—He has in the course of his work been using a modified form of the Loewy prism apparatus to measure the distances between pairs of stars approximately 120° apart. With this instrument the results depend solely upon micrometric observations of stars simultaneously seen in the field of the telescope, and therefore are similar in this respect to heliometer measures. Now if the distance between a pair of stars be computed from the places as given by meridian observations, and this distance be compared with the measured distance, any systematic error in right ascension depending on brightness of the stars will appear, if we may assume that the micrometer observations are free from such error. It has been suggested that meridian observations show the right ascensions of faint stars relatively greater than those of bright ones; and if this be so the distance between a pair of stars computed as above will be greater than the true (or measured) distance if the bright star precedes and will be less if the fainter star precedes; and so, to collect evidence on this point, Prof. Comstock has made such comparison for 38 pairs of stars which he has measured, and has arranged them in order of difference of magnitude of the stars composing the pair. Calling the difference of magnitude positive if the brighter star precedes the fainter, dividing the 38 pairs into groups, and taking means, the following table results:—

M.	*m.*	*v.*
−2·2	8	−0″·25
−0·8	7	−0 ·09
0·0	8	−0 ·01
+0·4	7	+0 ·09
+1·7	8	+0 ·26

Where M is the difference of magnitude, *m* the number of pairs in a group, and *v* with a positive sign the excess of the computed over the observed value. It may be added that these stars are all near the Equator, so that the differences are wholly due to errors in right ascension. The above table appears to confirm the conclusion that the right ascensions of fainter stars as given by meridian observations are too great, and Prof. Comstock says that from a graphical adjustment of the data he finds that between the second and seventh magnitude this excess amounts to $0''\cdot14 = 0^s\cdot009$ per magnitude for the right ascensions here employed, which are practically those of the 'Berliner Jahrbuch.'

Prof. Comstock then corrects the tabular right ascensions for this error due to magnitude just determined, and then by a further comparison of the computed with his measured distances finds that the 'Berliner Jahrbuch' places require a correction depending on right ascension given by the formula $+0^s\cdot014 \sin(\alpha + 145^\circ) + 0^s\cdot005 \sin(2\alpha + 90^\circ)$.

THE summer holiday season generally brings an influx of foreign and colonial visitors to Greenwich Observatory. The Eclipse and other circumstances have increased the number this year. We have lately had the pleasure of seeing Prof. E. Weiss of Vienna, Dr. Scheiner of Potsdam, Prof. Porro of Turin, Prof. Anguiano of Mexico, General Gore of the Indian Survey, Mr. W. E. Cooke of Perth, West Australia, Prof. Reed of Princeton, Prof. Newcomb, and Dr. Gill.

THE Eclipse shares the honours with the North Pole of a 'Punch' cartoon. Sir John Tenniel's picture for August 29 shows the Sun being toasted by the North Pole in these words:—"Your health, Sunny! with all their boats, balloons, telescopes, and things, they ain't found *us* out yet."

AST. NACH. 3369 contains an excellent series of double-star measures by Mr. R. P. Sellors of Sydney. These are the more welcome being southern doubles and close. We are glad to see that Mr. Sellors is fairly launched on this much needed work, and that he is also adding close pairs of his own discovering.

The death is announced of Prof. H. A. Newton, of Yale University, a mathematical astronomer who wrote much on meteor orbits.

We hear that Miss Agnes Clerke did not accompany Sir George Baden-Powell's expedition to Nova Zembla as was announced.

From an Oxford Note-Book.

A peaceful passage across the Pacific on the 'Empress of Japan' affords few incidents worthy of remark. We were kept in northern latitudes for the greater part of the journey, and the weather only changed from breezy to tropical on the last day. We also had a certain amount of fog, and did not get that glimpse of the Aleutian Islands which usually gratifies the voyagers by these boats in mid-transit. These islands were purchased along with Alaska by the United States for seven million dollars, and the citizens of the United States are thus enabled to amuse their friends (*more* Mr. Peter Magnus) by the following conundrum:—"Where would you locate a meridian midway between the most easterly and the most westerly point of the United States?" Those who wish to get the full flavour of the surprise should answer the question at least mentally before looking at the map.

We had of course the excitement of dropping a whole day on passing the 180th meridian. The actual passage occurred in the afternoon of Sunday, June 28, and accordingly Monday, June 29, was struck from our calendar. There was some speculation as to whether, had we passed the Line before noon, we should have dropped the Sunday; but Captain Lee wisely refused to commit himself on this point. It does not, of course, matter much which day is dropped, and sailors do not like to lose Sunday. The theoretical way of making the change would be, I suppose, for Sunday to turn into Monday at the time of passage; but this is inconvenient in practice as complicating the log. Chatting on the subject reminded Captain Lee of an examination question set him many years ago, concerning a ship supposed to be sailing north in latitude 75° and proceeding by a series of long tacks, each of which crossed the 180th meridian. One can see great possibilities in the way of examination torture in such a question.

At six o'clock in the morning of July 4 most of us were awakened by two or three jars, much as if the screw had come out of the water in the way familiar in rough weather. The sea was, however, perfectly calm at the time, and the chief engineer had no fault to find with his machinery. "I expect it was one of Johnny's earthquakes," he said; for Professor Milne, F.R.S., known to his many friends here as "Earthquake Johnny," is still assumed to have seismological control of the district. After ascertaining further that none of the American passengers had celebrated the Fourth of July in any way which might account for the disturbance, the above theory was adopted; and earthquakes were kept present to our mind during the day by a quantity of wreckage through which we passed, doubtless due to the recent disturbance in Yesso. At breakfast time Col. Rivers was reminded of an incident which had occurred to a sailing-ship in the Pacific, a submarine disturbance having taken place so immediately under it as to hoist it thirty feet above the water on to the top of a newly formed island. The occupants decided to remain there for the night, but their slumbers were disturbed by another shock, and when day broke they found that the island had split in two, and the ship had fallen and was now jammed endwise in the gap, below the water-line, but still protected from the sea by the walls of the gap. The situation suggested a means of escape by cutting the walls cautiously so as to admit the water; and the ship was thus floated up to the proper level and sailed out to continue her journey.

THURSDAY, JULY 9.—Japan is no longer a mere name to us, for we have been breathing Japanese air, sheltering from Japanese rain, and taking delight in watching Japanese children (and a few of the grown-ups) for some days. Arriving at Yokohama on a beautifully fine Sunday, we found H.M.S. 'Humber' awaiting us, and our instruments and baggage were transferred to her next day. The important decision where to go and when to go there was now to be taken; for just as we were leaving England we learnt that the conditions at Kushiro, our proposed destination, were unfavourable. After some consideration of information from various sources, Akkeshi Bay, just north of Kushiro, was decided upon, and it was arranged with Capt. Wyley to start next Monday (July 13) from Yokohama, in hope of reaching Akkeshi on July 17, which should give ample time for preparations before the eventful day. Meanwhile H.M. Minister, Sir Ernest Satow, has made life perfectly delightful to us for the space of three days in Tokio. Tomorrow we shall start for a glimpse of Nikko.

THE selection of a station was rather a complicated matter, there being some conflict in the evidence. On arrival at Yokohama, however, many difficulties were cleared away by a small pamphlet due to Mr. Nakamura, the head of the Meteorological Observatory. At the suggestion of Professor D. P. Todd, observations have been compiled for three years back at selected stations; and two stations are indicated as better than others, viz. Esashi on the north-east coast (long. 142° 30′, lat. 44° 57′)

and Akkeshi on the south coast (long. 144° 47′, lat. 43° 2′). At the former station there will be Professor Todd, Professor Terao, Director of the Tokio Observatory, and M. Deslandres, from Paris. At the latter we shall find Professor Schaeberle and Professor Shin Hiràyama from Tokio. The Japanese are not attempting any spectroscopic observations. Professor Todd has a large mass of apparatus, and hopes to get 500 photographs. He came in a yacht, the 'Coronet,' stopping a fortnight at Honolulu and having a good time generally; and we shall hope to see him after the eclipse.

PROFESSOR TERAO received us very kindly at the Observatory this morning. He is expecting a new instrument from Mr. Brashear to-day for eclipse work, and thus has not yet started for Akkeshi. The instrument will be a doublet of 8 inches aperture and 3 feet focal length, designed especially for the fainter parts of the Corona. Professor Hiràyama, on the other hand, has taken a photoheliograph of 12 feet focal length, to be used with a siderostat. Each has several assistants with smaller instruments. Work at the observatory is accordingly temporarily suspended, except the time-service. But we saw the two meridian instruments, the equatorial (7 inches), and the Talcott zenith telescope, which one of the assistants has been using for more than a year now on a variation of latitude investigation. Professor Terao is hoping for a larger equatorial, the dome for which is already built; and he has projects of getting a bigger and better observatory in a better position next year; but I do not know how much may be said on such a point.

YESTERDAY we were also welcomed very amiably by Dr. Hamao, the President of the Imperial University, and by Professor Yamagawa, the head of the Science Department. The President particularly assured us of his desire to assist the expedition in any way possible. Professor Yamagawa showed us over the various large buildings devoted to science—the fine natural history and other collections; and it was specially interesting to us to see the anthropological collection, with its Ainu relics, whom we hope soon to see in their native home. In the seismological department we learnt that nothing particular had been recorded on the morning of July 4, so that if the shock we felt was seismic it must have had its origin in the near neighbourhood of the ship. It is curious that nothing was felt in Tokio of the disturbance which caused the great disaster in the north on June 15, full accounts of which have doubtless appeared in the English papers. The telegram we saw at Banff, and which I mentioned in these notes last month, did not give a very accurate notion of the event, for it was only the south of Yesso which was touched, and more damage was done in the main island. They talk here of 30,000 lives lost.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 245. OCTOBER. 1896.

Remarks on the Progress of Celestial Mechanics since the middle of the Century.

[Continued from p. 326.]

Professor Gyldén began work with the methods of Hansen, and was gradually led to modifications of them, looking towards their use for indefinite lengths of time. This quality has latterly become imperative with him, and he has recently published the first volume of what is evidently intended to be a lengthy work entitled 'Traité Analytique des Orbites Absolues des Huit Planètes Principales.' To show the drift of Professor Gyldén's investigations, we cannot do better than give an analysis of this volume. At the outset the author introduces a class of curves he names periphlegmatic, that is, curves which surround a flame. The definition of this sort of curve is that it describes continually the space between two concentric spheres, and, at every point, turns its concavity towards the intersection of the radius vector with the inner sphere. In an application to the solar system the Sun is supposed to occupy the common centre of the spheres. The investigation is at first limited to the case where this curve is plane. A differential equation of the second order is derived which the radius vector of this curve satisfies, the independent variable being the angle described. The perpendicular distance between the spheres is called the diastem. The spheres are supposed to be drawn so that they touch the curve at the points where the radius becomes a maximum or minimum. Thus, in some cases, the spheres are regarded as fixed, in others as movable. In the latter case, however, the sum of their radii is supposed to remain constant. Thence we have two groups of periphlegmatic curves—those with constant and those with variable diastems. The author gives examples of both these groups, in most cases of which the line of apsides is variable, and considers the situation and density of the points of intersection of these curves with themselves.

The idea of an absolute orbit of a planetary body is this: an oval symmetrical with regard to an axis movable in space. While the axis remains constant in length (the half of it is called the protometre) the velocity of its motion may vary and the diastem may also vary. Professor Gyldén, however, admits into the expressions of these variations only terms whose period would become infinite did the planetary masses vanish. These terms he calls elementary. But elementary terms in the diastem and the longitude of the perihelion can produce terms in the co-ordinates having periods which differ but little from the time of revolution of the planet. These are also called elementary terms. But the two classes are distinguished, the first as being of the type (A), and the second as of the type (B). In all the formulas relative to this matter the author insists on keeping the arc described by the radius as the independent variable.

The co-ordinates are only approximately given by the preceding apparatus of expressions. They must then have certain complements added to them; these, however, are all composed of terms which would vanish with the planetary masses.

In deriving the elementary terms in the radius of a planet through the integration of a linear differential equation of the second order, Professor Gyldén attaches much price to his method of establishing the convergence of the series formed by the successive terms. As the latter are obtained through division by divisors of the order of the planetary masses, it might be feared that some of them would turn out to be very large. But the author prevents this by retaining in the coefficient of the dependent variable in the differential equation a quantity equivalent to the sum of the squares of all the coefficients in the integral. This is named the horistic or limiting function. It is plain such an expression could be introduced in the mentioned coefficient, provided that the linear equation is the truncated form of an equation containing the cube of the variable; and in the problem of planetary motion the approximations may always be so ordered that this shall be the case.

With regard to the co-ordinate which exhibits the departure of the planet from a fixed plane, Professor Gyldén does not greatly deviate from the procedure of Hansen in following the displacement of the instantaneous plane of the orbit. Only here, as in the preceding treatment of the radius, he would sharply distinguish the elementary and non-elementary terms.

At this point is introduced certain new nomenclature. As before we had diastem, now we have anastem to denote the product of the radius and the sine of the inclination; and what has generally been called the true argument of the latitude is here called the anastematic argument. Any angular magnitudes which are constantly moving through the circumference are astronomic arguments, and when they have the same mean velocity of rotation they are isokinetic; and isokinetic arguments are homorhythmic when, in each revolution through the circumference, they always retake together the same corresponding points. In like manner, the true anomaly is the diastematic argument, and we have diastematic and anastematic coefficients and moduli. It will be seen from this that Professor Gyldén does not shrink from imposing on us the labour of learning new terms.

Thus far we have been engaged in deriving the equations of the path followed by a heavenly body; it remains to show how we may find the point on that path occupied by the body at a given moment. There is then necessary an equation between the time and the variable assumed as independent, that is, the orbit longitude, or, more properly, the amount of angle described by the radius vector. If we suppose the absolute orbit to be described by the planet so that equal areas are passed over by the radius in equal times, it is plain that, on the attainment of a given longitude, a definite amount of time must have elapsed since the epoch. This it what Professor Gyldén calls the *reduced* time; and he computes the difference between it and the actual time required by the theory of gravity for the planet to arrive at the stated direction. This mode of proceeding does not differ from Hansen's except in the point that the absolute orbit is substituted for a fixed ellipse.

But this gives us correctly only the orbit longitude; for the radius and the latitude, which correspond in the absolute orbit to this reduced time, are not quite those which the planet has at the actual time. Consequently, Professor Gyldén proposes to compute two corrections, the one to be applied to the product of the eccentricity into the cosine of the true anomaly, the other to the sine of the latitude. Also the reduction of the orbit longitude to the plane of reference must be manipulated so that it comes out correctly.

The employment of the orbit longitude as independent variable throughout all the integrations necessitates a mass of very intricate transformations of terms from one shape into another. Also the integrations which bear on elementary terms must be kept distinct from those which bear on non-elementary terms. A degree of complexity is thus imparted to the subject, which makes it difficult to see when one has really gathered up all the warp and woof of it. Professor Gyldén has nowhere removed the scaffolding from the front of his building and allowed us to see what architectural beauty it may possess; it is necessary to compare a large number of equations scattered through the volume before one can opine how the author means to proceed.

The advantages claimed for the method are that it prevents the time from appearing outside the trigonometrical functions, and that it escapes all criticism on the score of convergence. The first is readily conceded; but many simpler methods possessing this advantage are already elaborated, and it is not so clear that the second ought to be granted.

No completely worked-out example of the application of this method has yet been published. The great labour involved will naturally deter investigators from employing it.

G. W. Hill.

[To be continued.]

The Astrographic Catalogue.

The resolutions adopted at the recent meeting of the Committee which has under its care the international work of charting the heavens by photography (see 'Observatory,' July) mark another stage in the progress of the work. For the first time the Committee now speaks of publication of results. At the initial meeting in 1887 the proceedings naturally consisted in resolving that the work be begun and in appointing committees. At the first meeting of the Permanent Committee, which was held in 1889, the distribution of the work between the co-operating observatories was settled and some details as to the taking of the plates. At the second meeting, in 1892 February, the deliberations again referred to photographic methods; but at the meeting of this current year the resolutions of the Committee deal with the measurement of and publication of results deduced from the plates which are to furnish the great Astrographic Catalogue, and this, as has been said, marks a fresh stage of the work and promises a first instalment of the result at a not far-distant date.

Although hitherto nothing which can be considered as a *result* of the Astrographic work has been published, there have appeared from time to time memoirs by various authors giving experimental measures, with deductions from them, and descriptions of methods, a slight consideration of which, such as is about to be made here, will show that the extracting of a star catalogue from a set of photographs is a matter demanding considerable care and skill, and that the application of old geometry to this new branch of astronomy is not without interest.

Especially we shall refer to two memoirs * by Prof. Donner, of the Helsingfors Observatory—one, published as far back as 1894, on the constants necessary for the reduction of plates; the other, published more recently, on the connection of a series of plates. These memoirs are selected, although similar investigations have been written by others, as Prof. Donner's books embrace most of the necessary points, and are therefore more illustrative of the whole subject.

It need scarcely be mentioned that the first step in dealing with a star photograph is to determine the rectangular co-ordinates of stars on it by measuring their position with respect to the lines of a reticule imprinted on the plate, the central lines of which reticule should be parallel and at right angles to a meridian. The displacement of the reticule from this theoretical position is determined from the measures of stars on the plate whose places are known, as is also the displacement of the centre from its desired position. The quantities which measure these displacements are called technically "plate-constants"; but the constants mentioned in Prof. Donner's title are not these, but more of the nature of instrumental constants which supply corrections to be applied to the measures.

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* Determination des constantes nécessaires pour la réduction des cliches près à Helsingfors pour la construction du catalogue photographique des étoiles. Helsingfors, 1894.—Sur le rattachement de clichés astrophotographiques. Helsingfors, 1896.

Obviously the first requirement to have accurate measures is to find the errors of the scale used for measurement, and Prof. Donner therefore begins by investigating the errors of his réseau. These errors depend on three deformations—the want of uniform spacing of the middle lines, the sinuosity of each line (that is, its departure from perfect straightness), and, thirdly, the defection of the angles between the lines from perfect right angles. A method of determining these errors was given by Dr. Gill in Mem. R.A.S. vol. li., but Prof. Donner has preferred a rather different plan. The maximum division error to be applied to Dr. Gill's réseau was about $0^{mm}\cdot0050$ and of Prof. Donner's about $0^{mm}\cdot0040$, a millimetre being nearly equivalent to a minute of arc on the plate.

It may be mentioned here that the accurate mean value of a division of the réseau is determined as a plate-constant (a and e) from the measures of the known stars which are on the plate; and this leads us to Prof. Donner's second section. If the plate when exposed be not normal to the optical axis of the telescope, the scale will be different in different parts of the plate, so that a, which measures the scale in one direction, is different to e, which measures the scale in a direction at right angles. This point was approached by Prof. Turner in 'Monthly Notices R.A.S.,' 1896 March, in a note on some measures made at Greenwich; but the evidence afforded by the values of a and e was not altogether conclusive as to the existence of this tilt. Prof. Donner examines the geometry of this mal-adjustment, and suggests that it might be determined by exposing the same plate to the same field in two positions of the telescope east and west of the meridian, when the difference of the orientation (b and d), as determined in the two positions of the instrument, would show the effect of the tilt It must, however, be quite realized that for this method of determining the tilt to be of value, it must be quite certain that the plate does not take up a different bearing in the telescope when the instrument is turned to the second position.

The next point considered by Prof. Donner is the distortion of the field of the object-glass, which he determines by means of six photographs of a group of stars whose relative positions had been determined by Dr. Gill by other methods in his parallax work on the planet Victoria. The distortion was assumed to cause terms in the measured distance from the centre represented by $as+bs^2+cs^3$; but the actual result showed that these were quite negligible.

Besides these instrumental corrections to be applied to measures, there may also be added the correction for personal equation of the measures: both his personality relative to other measurers (which must be taken into account if the whole plate is not measured by the same person) and also any peculiarity that he may have in not bisecting the images of large stars in the same way as fainter ones. Beyond these there are the astronomical corrections for differential refraction and aberration over the plate, the formulæ for which have been investigated by Dr. Rambaut and others; and when these have been applied and also the plate-constants, the observed standard rectilinear co-ordinates are known, from which equatorial co-ordinates can be found by pure geometry. The second resolution of the committee at their recent meeting leaves it a little doubtful which co-ordinates will actually be published as a catalogue, whether the rough quantities first measured or the finally deduced standard co-ordinates. It is reasonable to suppose that the resolution speaks of measures, corrected for errors of measurement and the instrument, but not by application of plate-constants.

The making of a complete harmonious catalogue of the whole sky leads to other considerations. Above has been explained a method by which the relative positions of stars on one plate, which covers a region of the sky about two degrees square, can be determined; that is, if certain stars are selected on the plate as fundamental, the places of all the other stars can be determined with respect to these; and the question arises, How are the positions of the stars in any one such area to be determined relatively to those in the areas adjoining? One method of effecting this may be shortly described as follows:—Since two adjoining plates overlap, and so contain some stars common to both, these stars might be considered as fundamental and the positions of the other stars on each plate be determined with respect to these, and so the stars in the common parts of adjoining plates can be used as connecting links. This method, elaborated it need scarcely be said, has been investigated by Prof. Turner, by M. Prosper Henry, and lately by Prof. Donner, who, in the second of the memoirs cited above, has discussed the measures on six adjoining plates and correlated their constants, so that the resulting positions of the stars (Right Ascension and Declination) as shown on different plates show remarkable accordance; but the time that would be required to make the catalogue on this plan would probably be enormous. Another way is to choose fundamental stars on each plate from a catalogue made from meridian observations, and whose relative positions are therefore known. The first plan is about equivalent, it will be remarked, to making a catalogue from meridian observations, of which the separate groups do not embrace more than about twenty minutes of right ascension, which would be considered bad practice (at Greenwich a group of observations is not considered satisfactory unless it extends over six hours); but the Astrographic Catalogue made on the second plan would depend on fundamental stars, which are equivalent to clock stars, whose connection would have been already well made. This method must certainly be the more expeditious, and is no doubt the method contemplated by the Permanent Committee in their third resolution. It would seem to be the only method by which the early publication they wish for can be accomplished.

Perseid Radiants, 1895 *and* 1896.

It may be useful to summarize the radiants of the August meteors as determined by various observers during the last two returns of this important shower. The materials are not very numerous when we consider the strength and duration of the display, but in 1895 the Moon was full on Aug. 5, and, being visible nearly all night during the ensuing week, seriously interfered with observation. In 1896 there was no such hindrance, our satellite being new on Aug. 9, but the period was a cloudy one. The table is arranged according to date, and the abbreviations in last column are :—

E.R.B.	E. R. Blakeley.	Dewsbury.
D.B.	D. Booth.	Leeds.
H.C.	H. Corder.	Bridgwater.
W.F.D.	W. F. Denning.	Bristol.
J.A.H.	J. A. Hardcastle.	Chelmsford.
A.S.H.	A. S. Herschel.	Slough.
W.H.M.	W. H. Milligan.	Belfast.

Year.	Day of month.	Radiant. α.	Radiant. δ.	No. of meteors.	Observer.
		°	°		
1895	Aug. 2	35	+55	16	E.R.B.
	3–4	43	+57*	6	W.H.M.
1896	4	38	+54	5	E.R.B.
	5	37	+57	10	W.H.M.
	6	42	+56	7	W.F.D.
	6	45	+57	15	H.C.
1895	7	39	+53	11	E.R.B.
	7	40	+56	7	H.C.
	7	41	+57	5	W.F.D.
	9	43	+57	23	H.C.
1896	9	40	+58	22	W.H.M.
1895	10	45	+55	17	W.F.D.
1896	10	46	+57	11	J.A.H.†
	10	43	+58	20	E.R.B.
	10	45	+57	69	W.F.D.
	10	47½	+58	...	D.B.
1896	Aug. 10	47	+58	30	H.C.
1895	11	45	+56	13	E.R.B.
	11	44	+58	7	W.F.D.
1896	11	45	+55	13	E.R.B.
1895	11	43	+58	...	A.S.H.
	11	43½	+58	72	H.C.
1896	12	46	+57	7	W.F.D.
	12	48	+57	6	E.R.B.
	12	48	+60	30	H.C.
1895	13	51½	+56½	14	H.C.
1896	13	50	+59	10	E.R.B.
1895	14	51	+58	6	E.R.B.
1896	14	51	+59	24	E.R.B.
	15	50	+58	8	W.H.M.
1895	18	51	+56	11	H.C.

* This position is evidently too far east.

† Observations reduced by Prof. A. S. Herschel.

When we reflect that the table is formed by the independent positions of several different observers, and that such observations are seldom consistent, owing to the difficulty in fixing the radiant accurately, the progressive displacement from night to night is pretty well shown. From the nature of the observations it is impossible to avoid small errors and to derive a series of positions exhibiting a *regular* advancement of the radiant, and all that can be fairly expected from a collection of different results is that they will show the easterly movement in a general way. This the table does very satisfactorily. Compare, for instance, the mean positions for three intervals, as follows:—

Aug. 2–5 ……	38°	+56°	4 radiants.
10–11……	45	+57	11 "
12–15……	50	+58	9 "

It is true the radiants for Aug. 11 are slightly W. of those for Aug. 10 instead of being E., but this is occasioned by trivial errors in observation. And it must be remembered that 1896 is leap year, and that the radiant on 1896 Aug. 10 would therefore be almost identical with that on 1895 Aug. 11. In the list it will be seen that 5-6ths of the radiants on Aug. 10 were obtained in 1896, while a nearly similar proportion of those on Aug. 11 were obtained in 1895. This partly explains why no advance is shown in the R.A. on the two dates. But in any case, the motion is so slight in 24 hours that it cannot always be defined from the most exact materials.

It does not appear that any good series of Perseid observations have been recently made in the latter part of July, and this is what we now essentially require. The shower is certainly active on July 19, and probably before that date in a very feeble way. It may be worth mentioning that during the last half of July the R.A. of the Perseid radiant nearly corresponds with the day of the month. Thus, on July 19, the shower is directed from R.A. 19°, but the agreement is not precisely maintained, for the degrees of R.A. of the radiant advance a little faster than the days of the month.

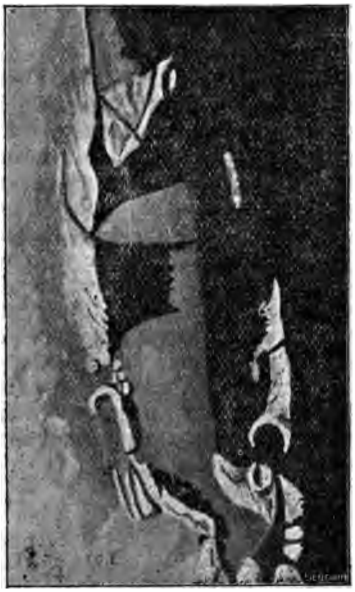
In 1897 a good opportunity will occur for securing records of early Perseids, for there will be several hours of dark moonless sky on every night between July 24 and Aug. 9. Those observers who care to witness for themselves what I have always found the most interesting feature of this rich shower should therefore avail themselves of such clear nights as occur within the interval named.

I had intended summarizing all the radiants for the Perseids back to 1893, but there seemed no necessity for this in view of a comparative table of the positions for the year mentioned, which appeared in the report of the Meteoric Section of the B. A. S. ('Memoirs,' vol. iii. p. 10). In that table the motion of the radiant from R.A. 39° on Aug. 5 to R.A. 54° on Aug. 18 is splendidly defined from observations by Mr. Blakeley at Dewsbury and by the writer at Bristol. W. F. Denning.

Bristol, 1896, Sept. 22.

Selenographical Notes.

Grimaldi.—As Neison remarks, this magnificent walled-plain had it been more centrally situated would probably have been included among the smaller "seas," its vast area of about 14,000 square miles, nearly double that of North and South Wales combined, entitling it to this distinction. The phenomenal duskiness of its smooth interior attracted the attention of lunar observers as far back as the time of Hevelius, who named it, presumably after the old lake port of Alexandria, "Palus Mareotis," and shows it prominently in his ancient chart. The border of Grimaldi is one of the most broken and discontinuous on the Moon's visible surface. It would be hard to find any other lunar formation which exhibits so many gaps and irregularities in its contour, or whose rampart varies so greatly in altitude. The eastern border is the most regular, having an average height of about 4000 feet, but sinking to a comparatively insignificant altitude about midway between the N. and S. extremities of the enclosure. It includes



one large crater (shown in the drawing as partially illuminated, with a smaller depression adjoining it on the N.) and many ravines and cross valleys, seen at a later stage of illumination.

The accompanying drawing was made about 9^h on March 30, 1893, with a power of 284, definition being fairly good. The most noteworthy feature at this phase is the beautiful shadow of one of the loftiest mountain-masses on the western wall with its jagged outline thrown on the dark steel-grey floor, only about one half of which is in sunlight. (This shadow was sketched at 9^h 20^m.) Very clear indications of low ridges, running in a longitudinal direction over the interior, were apparent, but neither on this or on any former occasion could I detect any craterlets thereon. The floor of Grimaldi in this respect differs greatly from the other great walled-plain, Schickard, also on the eastern limb, which not only includes more than thirty of these objects, large and small, but many rills and chasms also. At the extreme southern end of Grimaldi the border widens into a broad plateau which is traversed by two rill-valleys, forming a V-shaped marking under a low morning Sun.

Though rather unfavourably situated for the purpose, it would be well if some observer would undertake tint observations of the dark floor, comparing its hue at various times with Julius Cæsar, Boscovich, Plato, and the interior of the neighbouring Riccioli. The irregular dark patch which covers nearly the whole of the north-east quarter of the floor of this latter formation appears to me at certain times to be obviously much darker in places than any portion of the area of Grimaldi, though the latter is classed as the darkest spot on the Moon's surface. A similar dusky patch at the north end of Schickard and another of a rectangular shape at the south-west corner of the same object vary, I think, not only in intensity of hue, but also in shape. At any rate, I have careful drawings of these features made nearly a quarter of a century ago, which differ notably from those of a recent date.

Good sketches are needed of the region extending from the western side of Grimaldi to the eastern shore-line of the Mare Procellarum, including that most complex and abnormal jumble of rings, Damoiseau and its surroundings.

Beaumont House, Shakespeare Road,
Bedford, 1896, September 19.

T. Gwyn Elger.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

The Jubilee of the Discovery of Neptune.

Gentlemen,—

It is inevitable that some of our thoughts should this month be devoted to the above subject, and perhaps a few words on it may be of interest to some of your readers, though they cannot contain anything new.

It was in the year of the jubilee of the discovery of Uranus (1831) that the first meeting of the British Association was held at York. And at the second meeting, presided over by Dr. Buckland at Oxford in 1832, Prof. (afterwards Sir George) Airy presented that comprehensive Report on the Progress of Astronomy, the perusal of which some years afterwards first led Adams to conceive the idea of taking up the question of the perturbations of Uranus and whether the unexplained irregularities might be produced by an exterior planet. Airy, however, expresses no opinion on the point, his exact words being—"It appears impossible to unite all these observations [of Uranus before and after its discovery as a planet] in one elliptic orbit, and Bouvard, to avoid attributing errors of importance to the modern observations, has rejected the ancient ones entirely. But even thus the planet's path cannot be represented truly; for these Tables, made only eleven years ago, are now in error nearly half a minute of space."

Early in the month (September 1846) in which Neptune was actually discovered, a meeting of the British Association was held at Southampton. Sir John Herschel then resigned the chair to Sir R. Murchison; and, in his speech on the occasion, referred to the probable prospect of the discovery of a planet beyond Uranus, which he says would then be seen "as Columbus saw America from the shores of Spain. Its movements have been felt, trembling along the far-reaching line of our analysis, with a certainty hardly inferior to that of ocular demonstration."

At that time Challis was still searching for the stranger at Cambridge; and a few days afterwards Dr. Galle (who, we are glad to know, still survives, though he is the only direct actor in the great event who does) observed it at Berlin. On the 1st of October Sir John Herschel addressed a letter to the 'Athenæum,' which appears in the number of that journal (having been received just in time) for Oct. 3, in which absolutely the first public mention is made of Adams's calculations and prediction of the probable place of the unknown planet. Perhaps, therefore, I may be permitted on this occasion to quote part of it. After mentioning what he had said at Southampton and also what he had heard from Bessel about four years before respecting his intention to investigate the irregularities in the motions of Uranus and their probable cause, he says:—

"The remarkable calculations of M. Le Verrier—which have pointed out, as now appears, nearly the true situation of the new planet, by resolving the inverse problem of the perturbations—if uncorroborated by repetition of the numerical calculations by another hand, or by independent investigation from another quarter, would hardly justify so strong an assurance as that conveyed by my expressions above alluded to. But it was known to me at that time (I will take the liberty to cite the Astronomer

Royal as my authority) that a similar investigation had been independently entered into, and a conclusion as to the situation of the new planet very nearly coincident with M. Le Verrier's arrived at (in entire ignorance of his conclusions), by a young Cambridge mathematician, Mr. Adams—who will, I hope, pardon this mention of his name (the matter being one of great historical moment), and who will doubtless, in his own good time and manner, place his calculations before the public." The process of conviction in Sir John Herschel's mind seems to have proceeded in the reverse order to that which it did in the minds of Airy and Challis—Adams's calculations confirming Le Verrier's, instead of Le Verrier's confirming Adams's. But surely no one can be surprised that the feeling in them all should have been converted from one of interest to one approaching confidence (leading Airy and Challis to think it desirable to undertake the great labour which would probably be required) when the difficult problem had been solved with practically the same result by *two* mathematicians.

There is only one thing more that it seems worth while to say now. I have not seen mentioned in any English book a fact which was stated by Dr. Galle in the 'Astronomische Nachrichten,' viz. that the famous sheet in Bremiker's star-charts which covered the place of Neptune had been completed and engraved before the end of 1845, and therefore nearly a year before the discovery; but for some reason Encke had delayed its distribution, probably waiting till another should also be ready. When D'Arrest suggested reference to this chart in the search for the new planet, Galle found one in a drawer with others not arranged in order.

Yours faithfully,

Blackheath, 1896, Sept. 5. W. T. LYNN.

P.S.—Dr. Galle's papers in the 'Astronomische Nachrichten,' referred to above, are contained in Nos. 2134 and 2414, vol. lxxxiv. col. 349, and vol. ci. col. 219. In the latter he points out an error in Engelmann's German translation (p. 392) of Prof. Newcomb's 'Popular Astronomy' (not in the original), where it is stated that Le Verrier in his letter to Dr. Galle suggested to him to make use of the map in question in looking for the planet, the fact being that at that time Le Verrier could have had no knowledge of the completion of the map. It is strange that this mistake is not corrected in Dr. Vogel's revised edition (published in 1892) of Engelmann's translation (see p. 403). May we hope that Prof. Newcomb will oblige us all by a third edition of the English original?—W. T. L.

OBSERVATORIES.

[Continued from p. 339.]

JENA (University Observatory). *Otto Knopf.*—This observatory has a new refractor of 174 mm. (6·9-inch), which appears to be perfectly satisfactory as compared with the old one (200 mm.). The images appear perfectly round in any part of the field, and the background remains dark while a bright object, such as Jupiter, is in the field. With the 200-mm. O.G., at best only a magnifying-power of 200 could be used, and ξ Ursæ Maj. (2″·1) could with difficulty be separated. The new glass will easily separate the components of *i* Cassiopeiæ (2″) of 4- and 7-mag. with a power of 120, and with 300 the components of Σ 2744 (1″·6) and 20 Pegasi (1″·4) could easily be measured. With the refractor places for several small planets and Comet 1895 IV. (Perrine) were obtained. The Transit was used for time-determination.

JENA. *W. Winkler.*—Small instruments. Occultations. Observations of Jupiter's satellites. Observations of sun-spots on 251 days with a 4-inch refractor.

KALOCSA. *J. Fenyi.*—The work here has been on the same lines as in previous years. The Sun's limb was examined for prominences on 192 days, and the weather was such that on 166 occasions the whole limb was carefully inspected. A noticeable decrease in activity was apparent, although prominences of 100″ in altitude were observed on 50 occasions as against 64 in 1894. Two remarkable eruptions were observed on July 15 and Sept. 30. In the former the velocity in the line of sight was 858 klm. per second, while on the latter day the prominence reached the extraordinary height of 11′ 28″, with a mean velocity of 448 klm. per second. Sun-spots were observed by P. J. Schreiber on 260 days.

KARLSRUHE. *W. Valentiner.*—A large number of Transit-Circle observations for variation of latitude.

KÖNIGSBERG. *H. Struve.*—The Repsold Meridian-Circle was used by Dr. Rahts for time observations and stars between +83° and +85° Dec. At this observatory also the Sun and planets are regularly observed. Dr. Cohn employed the heliometer for parallax work on β Cygni, θ Sagittæ, *x* Delphini, *b* Cygni, and θ Persei, and Dr. Franz for observations of Σ wide pairs in the zone +15° to +30°, for positions of lunar craters. Comets Perrine and Brooks were observed.

MILAN. *Schiaparelli.*—The 18-inch was employed in measuring close doubles, and the 8-inch Merz was also used by Prof. Celoria for double-star work. Longitude work.

MUNICH. *H. Seeliger.*—Double-star work with the 10½-inch refractor. Small planets. Comets 1895 II. (Swift), 1895 III. (Brooks). Drawings of Venus. Meteorology.

O'GYALLA (UNGARN). *Dr. Ludwig Steiner.*—Sun-spot observation. The results of the years 1894 and 1895 are:

Year.	Observing days.	Spots.	Groups.	Rel. Nos.
1894	145	1857	595	53·66
1895	133	1785	485	51·41

Observations of Comet 1894 II. (Gale). Meteorology.

POTSDAM. *H. C. Vogel.*—Spectroscopic work on β Lyræ, bright stars in Orion, and many others. Dr. Scheiner found Cleveite in at least 25 spectra out of some 150 observed. Micrometer measures of Jupiter and Saturn. The photometric work on the Durchmusterung was continued. Researches on variable stars. Dr. Schwassmann, who was engaged on the work of the Photographic Chart, has been succeeded by Miss A. Everett (formerly of Greenwich). At the end of 1894 the plates taken numbered 380 and those measured 46, while at the end of 1895 these numbers were 625 and 66 respectively.

STRASBURG. *E. Becker.*—The 18-inch refractor was used for observations of Comets Swift, Faye, Perrine, and Brooks. The meridian work has been carried on in the complete form of previous years, the Sun, Moon, and planets being regularly observed, and over 3000 observations were made of stars.

UTRECHT. *Oudemans.*—Occultations of stars by Moon. Positions of a few small planets. Variable stars. Drawings of Jupiter. Meteorology.

VIENNA (*M. Edler v. Kuffner*). *L. de Ball.*—1700 observations of zone and fundamental stars, making 16,518 since 1892 January. These are in a forward state of reduction. It is intended reducing them to epoch 1900. Dr. Neckar has worked with the Prime Vertical Transit.

ZURICH. *A. Wolfer.*—Sun-spot observations.

	Observing days.	Sun free from Spots.	Rel. Nos.
1894	295	0	78·1
1895	296	0	63·9

On 160 days complete observation of the Sun's limb was made for prominences. Some photographs of the Moon and Jupiter. Time-service.

PUBLICATIONS.

DR. AUWERS' ZONE CATALOGUE (continued from page 343).—The programme arranged for those cooperating in the zone observations of the 'Astronomishe Gesellschaft' included a comparison with older catalogues and a determination of proper motions. This has been carried out thoroughly by Prof. Boss in the Albany Zone, Dr. Becker in the Northern Berlin Zone, and provisionally by Prof Rogers (who did not wish to delay his Catalogue till the completion of a full discussion) for the Cambridge (Mass.) Zone. Prof. Auwers, it almost goes without saying, has compared his observations with previous Catalogues very fully and systematically. The Right Ascensions and Declinations of all the stars common to each of the compared Catalogues are reduced to 1875·0, and the differences from Dr. Auwer's Catalogue are given. Altogether about 19,000 comparisons were made, and a discussion of these is given for each Catalogue in the Introduction, with a determination of the corrections to be applied to the several Catalogues to bring them into harmony with the system adopted by the 'Astronomische Gesellschaft' Catalogues. The volume published by Dr. Auwers may almost be styled an Encyclopædia of the observations of the stars down to the ninth magnitude between 14° 50′ and 20° 10′ North declination. The comparisons with Dr. Auwers' re-reduction of Bradley's observations are only given in those cases where he considers a redetermination of the proper motions necessary, and the comparison with the Greenwich Catalogues is not given in detail, though these have been used in the determination of the systematic errors of the Berlin Zone observations.

Of the comparisons with Bradley and Mayer, nothing need be said. About 20 stars in this zone are contained in Hertzsprung's reduction of Maskelyne's observations of 231 faint stars, and the smallness of the residuals is noticeable. The systematic corrections to Piazzi's Catalogue are determined by comparison with places determined by interpolation between Bradley 1755 and Berlin 1875, 256 stars being available for the purpose. A further comparison (for all declinations) is made between Piazzi and the Fundamental Catalogue of the Astron. Gesell. It is found that the azimuth correction, $+0^{s}\cdot143 \tan \delta$, which Argelander and Struve concluded was required by Piazzi's observations, is not valid between 8^{h} and 12^{h}. The corrections applicable to the declinations are deduced and are of about $-3''\cdot0$ in magnitude. Corrections to Gould's reduction of D'Agelet's observations are deduced by comparison with the stars common to Piazzi. In the case of Lalande's observations Baily's Catalogue has been used only as an index, and Dr. Auwers has gone to the 'Histoire Céleste' and re-reduced such zones as he required by the aid of Von Asten's tables. 3624 observations are re-reduced, and corrections to the separate zones, as well as systematic corrections dependent on the Right Ascension and Declination, determined. Bessel's zone observations are similarly re-reduced with the help of Dr. Luther's tables. Among other catalogues compared, and to which systematic corrections are deduced, are Bossert's Supplement to Lalande, Struve's 'Positiones Mediæ,' Taylor's General Catalogue, Rümker's Catalogue, Lamont's Münich Observations, Argelander's Bonn Observations, Schjellerup's Catalogue, Schur's Reduction of Klinkerfue's Observations, and the Pulkova, Paris, and Glasgow Catalogues.

Having made all these comparisons, Dr. Auwers is in a position to determine the proper motions of the stars in his zone. It is somewhat surprising that the Greenwich 1880 Catalogue has been omitted in some of these determinations, where it would have been most useful, as most of the Bradley stars whose proper motions are redetermined are contained in it. The corrections to the proper motions previously determined by Dr. Auwers are usually not much greater than $0^{s}{\cdot}0010$ and $0''{\cdot}010$. Among the 1300 stars of which proper motions have been determined, there are a good many cases in which the existence of a proper motion is not made out with any certainty, and which might have been omitted from the catalogue of proper motions without any detriment to it; but there are a large number which are certain and well determined. An interesting analysis is given in the introduction of the number and distribution of the stars with different proper motions, and of the average relation to the magnitudes of the stars. A list of the stars whose proper motion on a great circle is greater than $0''{\cdot}25$ annually is given, from which the following list of those stars with proper motions greater than $0''{\cdot}5$ has been selected, with the name of the catalogue in which the star first occurs:—

Catalogue.	Approximate R.A. and Decl., 1875.		Proper Motion.	Magnitude.
	h m s	° ′ ″	″	
Lalande	1 15 30	18 1 38	0·553	7·6
Bessel's Zones	1 18 6	17 51 14	0·685*	8·8
Bradley	1 35 43	19 39 38	0·719	5·3
Bessel's Zones	2 43 39	15 12 19	0·535*	9·0
Bradley	5 0 4	18 28 31	0·543	5·2
Bradley	9 5 27	15 29 53	0·585	7·0
Bradley	11 42 41	15 16 15	0·502	2·0
Lalande	13 6 17	18 0 54	0·586*	7·8
Maskelyne	13 10 38	17 41 13	0·713*	7·0
Auwers	13 39 1	18 28 48	1·893*	9·2
Lalande	13 39 24	15 34 18	2·263	8·5
Bradley	14 9 58	19 50 1	2·275	1·0
Bessel's Zones	14 40 33	17 3 22	0·929*	8·8
D'Agelet	15 7 8 15 7 9	19 44 45 19 45 9	0·692	6·7
Bradley	15 50 41	16 4 15	1·319	3·8
D'Agelet	16 23 23	18 40 37	0·526	7·0
Bonn	17 33 15	18 37 55	1·180*	9·2
Bessel's Zones	18 43 23	17 18 53	0·576*	9·0
Munich	18 55 17	18 55 12	0·568*	9·5
Lalande	19 56 51	15 15 57	0·609	7·0
Bradley	19 58 30	16 44 0	0·557	5·5
Lalande	20 5 26	13 48 14	0·564	7·0
Bessel's Zones	21 6 12	17 14 55	0·913	7·3
D'Agelet	23 29 42	17 44 38	0·696*	8·0

The asterisk denotes those stars whose proper motion was
previously known. The tenth star in the above list was
observed by Dr. Auwers; he had made only a single observa
and the subsequent observations by Dr. Battermann for id
fication showed the large proper motion.

It is quite unnecessary to say a word of the great value c
catalogue and of the determination of proper motions, or
immense labour involved in it. Dr. Auwers refers to
operation of several well-known German astronomers w

taken a considerable share in the work—Dr. Romberg, Dr. Battermann, Prof. Küstner, Dr. Lamp, Dr. Harting, and Dr. Stumpe, who, along with Dr. Auwers, are to be congratulated on the result of their work. F. W. Dyson.

Elements of Astronomy *.—Sir Robert Ball has lately revised his book which bears this title, and Messrs. Longmans have kindly sent us a copy of the new edition. This is one of the well-known "Text-books of Science" series, an octavo volume written in numbered paragraphs, each with an italicized heading showing the subject it treats of; and though, like the others of the series, the book is intended primarily for beginners, the author has aimed at making it useful to more advanced students by supplying a long chapter under the heading "Astronomical Constants," containing lists of various determined values of each constant, with the authority and reference for each value, arranged in chronological order; in fact, each list forms a short bibliography of some branch of astronomy. The first part of the book, which is written for the beginner, is naturally of a simple nature, but is written in the Lowndean Professor's usual accurate style; and, as evidence of revision, we note that the statement that sun-spots are hollows in the solar surface, with the diagram illustrating Wilson's theory, is qualified by a sentence evidently referring to Mr. Howlett's views, which pleases us, because this diagram has been given in books of instruction so often and with such definiteness, that the theory that sun-spots are holes has become accepted popularly on rather insufficient evidence. The second part of the book is certainly useful to any astronomer, although, as might be expected, it is not difficult to find omissions; for instance, in the list of star catalogues the last mentioned is the Greenwich 1880, and in the list of measures of Saturn's rings, Prof. Barnard's recent measures are given, but not those made at Greenwich, which is scarcely doing justice to the 28-inch; and in the list of writers on the zodiacal light the recent researches of Prof. Searle are not mentioned. We noted some other omissions which it would serve no good purpose to particularize, and which do not alter our opinion that the work will prove a useful one to astronomers of various calibre.

NOTES.

Comet Notes.—Two new comets were discovered on Sept. 4 last; we believe that the discovery of two new comets on the same night is unprecedented. The first of them (1896 *d*) was discovered by M. Giacobini at the Nice Observatory. Prof. Kreutz has computed the following elements from observations on Sept. 5, 6, 7 (Ast. Nach. 3378):—

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* 'Elements of Astronomy.' By Sir Robert Stawell Ball, LL.D., F.R.S. New edition; thoroughly revised. (Longmans, Green, and Co., London.) 1896.

T = 1896 Oct. 8·003 Berlin M.T.
ω .... 152° 2′ ⎫
☊ .... 195 40 ⎬ 1896·0.
i .... 8 45 ⎭
log q .. ... 0·0400

These elements are very uncertain, and the orbit may not improbably prove to be an ellipse of short period. The comet was very faint when discovered, but the brightness is increasing and will reach a maximum on Oct. 21, when it will be 2·5 times that at discovery, its distance from the Earth being then about 39 millions of miles.

The other comet (1896 *e*) was discovered by Mr. Brooks at Geneva, U.S.A.; it was also very faint, and as the brightness is steadily decreasing it will only be visible with large instruments during October. Dr. Lamp has computed the following elements from observations on Sept. 6, 8, 10 (Ast. Nach. 3378):—

T = 1896 July 16·6326 Berlin M.T.
ω .... 48° 41′ ⎫
☊ .... 152 6 ⎬ 1896·0.
i .... 88 21 ⎭
log q ...... 0·0832

The following ephemerides (for Berlin midnight) have been computed from these elements:—

	Comet Giacobini. R.A.			S. Dec.		Comet Brooks. R.A.			N. Dec.	
	h	m	s	°	′	h	m	s	°	′
Oct. 1....	18	30	24	12	36	16	30	33	46	28
5....	18	49	0	13	25	16	51	17	44	11
9....	19	9	32	14	10	17	10	20	41	48
13....	19	32	32	14	50	17	27	56	39	25
17....	19	57	40	15	22	17	44	8	37	1
21....	20	24	47	15	40	17	59	8	34	39
25....	20	53	24	15	43	18	13	0	32	23
29....	21	23	1	15	30	18	26	0	30	10

The following startling telegram was received from Kiel on Sept. 23:—

"Lewis Swift announces small bright comet Sunday night one degree east of Sun. Monday same; north; fainter.—Kreutz."

No further details are yet to hand. The comet must be one of unusual brilliance, but the observation is not unprecedented, the Great Comet of 1882 having been seen in contact with the Sun's limb

The following is a continuation of the ephemeris of Brooks' Comet (1889 V.); this is by J. Bauschinger, and is for Berlin midnight (Ast. Nach. 3378):—

	R.A.	S. Dec.		R.A.	S. Dec.
	h m s	° ′		h m s	° ′
Oct. 7....	22 8 37	16 41	Oct. 23....	22 15 59	14 24
11....	22 9 41	16 11	27....	22 19 2	13 45
15....	22 11 17	15 37	31....	22 22 30	13 3
19....	22 13 24	15 2	Nov. 4....	22 26 23	12 20

The brightness is now steadily declining, and the comet is a difficult object, even in the largest telescopes. At no time during the present apparition has the brightness approached that of 1889. It has not made quite such a close approach to the Earth, but the difference must be chiefly due to physical change in the comet.

Two definitive orbits of Comet Holmes (1892 III.) have recently been published. The first is by M. H. J. Zwiers ('Publications of the Amsterdam Royal Academy of Science'), the second by Dr. Ernst Kohlschütter. The number of observations available is very large, and both computers have reduced it considerably by the free rejection of observations showing large residuals. There is no evidence of any change in the orbit at the time of the sudden increase of brightness in January 1893; the probability that this was produced by a collision with an unknown body is thereby lessened. The following are the respective orbits:—

	ZWIERS.		KOHLSCHÜTTER.	
Epoch and osculation...............	1892 Nov. 4^{d}·0 G.M.T.		1892 Dec. 11^{d}·0 Berlin M.T.	
M	20° 30′ 42″		25° 48′ 8″	
ω	14 15 52	1892·0.	14 16 51	1890·0.
π	345 57 26		345 56 4	
☊	331 41 34		331 39 13	
i	20 47 16		20 47 12	
φ	24 10 46		24 9 54	
e	0·409596		0·409366	
μ	514″·04		514″·27	
log *a*	0·55934		0·55921	
Period...............	2521·2 days		2520·1 days	
T_1	1892 June 13·3497 G.M.T.		1892 June 13·3786 Berlin M.T.	
T_2	1899 May 9·6		1899 May 8·5	

M. Zwiers has also calculated the perturbations by Jupiter and Saturn up to the time of the next return, for which he finds the following elements:—

T_2 = 1899 April 27·97 G.M.T.

π	345° 47′ 51″	1899·0.
☊	331 43 38	
i	20 48 15	
φ	24 17 2	
log *e*	9·61411	
μ	516″·41	

He gives an ephemeris for 1898, of which the following is an abridgement; the places are for Greenwich noon:—

	R.A.	S. Dec.		R.A.	S. Dec.
	h m	° ′		h m	° ′
Feb. 16	16 26	42 7	June 16	16 5	51 1
Mar. 18	16 52	45 44	July 16	15 46	47 10
Apr. 17	17 0	49 20	Aug. 15	15 56	43 2
May 17	16 41	51 49	Sept. 14	16 31	39 55

The brightness is at a maximum on July 4, when it is the same as on 1893 Jan. 15 (the day of the sudden change of brightness). The remarkable fluctuations in light of this comet make its visibility at the next return decidedly uncertain.

Herr Elis Strömgren has published definitive elements of Comet 1890 II. (Brooks) (Acta Reg. Soc. Phys. Lund, tom. vi.). This comet was under observation from 1890 March 21 to 1892 Feb. 4, an unusually long period; the number of observations available is 899. The following are the elements obtained, after the application of planetary perturbations:—

$$
\begin{array}{lll}
\multicolumn{3}{l}{T = 1890 \text{ June } 1{\cdot}57024 \text{ Berlin M.T.}} \\
\omega \;\ldots\ldots & 68^\circ\ 56'\ 4'' & \multirow{3}{*}{} \\
☊ \;\ldots\ldots & 320\ \ 20\ \ 43 & \left.\right\} 1890{\cdot}0. \\
i \;\ldots\ldots & 120\ \ 33\ \ 22 & \\
\log q \;\ldots & 0{\cdot}28048 & \\
e \;\ldots\ldots & 1{\cdot}00041 &
\end{array}
$$

It appears that the hyperbolic nature of the orbit can be accounted for by planetary perturbations, and that the orbit before entering the solar system was parabolic, or possibly even elliptical.

A. C. D. C.

Minor Planet Notes.—Six new planets have been discovered during the past month, all by Prof. Wolf. CU was discovered on Sept. 3, CV, CW, CX, CY, CZ on Sept. 7. The latter five planets were all on the same photographic plate. Planet 352, discovered by Wolf 1893 Jan. 12, has been named Gisela. A. C. D. C.

A Remarkable Group of Sun-spots.—During the last two years the numbers and areas of sun-spots have undergone a decrease, which has been very steady on the whole, though, as usual, there have been a number of minor fluctuations. Observers therefore were quite unprepared for the abnormal outburst which has just passed out of sight at the western limb. A small isolated spot was seen close to the east limb on Sept. 9, and on the following day was seen to be the herald of a magnificent group. The unfavourable weather prevented further observation until Sept. 13, by which time the group had come completely into view, and was seen nearly in its true proportions. It formed a long straight stream, the spots in the preceding half of which were so close together as almost to form a single rift in the solar surface. The latter half was less condensed, and there was a decided tendency of the following spots to spread out and separate. There was no striking change on the 14th and 15th, and towards midnight on the latter day the first spots of the long stream reached the central meridian. It was very nearly two complete days before the long procession had entirely passed by. As seen on Sept. 16, the group extended over 24° of solar longitude, or 180,000 miles. Its breadth, on the other hand, was much inferior, only being 5° at the broadest. The principal axis of the group was inclined at an angle of about 15° to the Sun's equator, the latitude increasing from the front of the group to the rear. A decided tendency to segregation had been noted, especially in the afterpart of the group, before it had reached the central meridian, and by the 19th the development, usual in long streams, of a deep, dark nuclear spot had taken place at the head of the group, the front edge of the leader being especially sharply defined and regular. One-third of the way down the group was a second regular spot with a dark double nucleus. The latter end of the group was by this time fast breaking up.

By the next day the group had become divided into three distinct sections. By the 21st, the group now being near the limb, the preceding portion was reduced to two regular spots, of which the second was much the larger; a wide gap intervened between the latter and the poor remnants of the tail of the group. By the 23rd the leader had disappeared round the west limb, and the second larger, regular spot and one member of the tail were alone in sight.

Though this group almost establishes a record as to length for a continuous stream, and though as to actual area covered it must rank among the half-dozen largest groups of the present cycle, it was not of the type with which the greatest magnetic disturbances are usually associated. Still, shortly after the last members of the stream had crossed the meridian, a very distinct disturbance set in, and in some parts of the country considerable auroral displays were noted. The magnetic oscillations set in sharply, shortly after 6 o'clock, on the morning of September 18. The fluctuations became rapid about twelve hours later, and terminated a little before noon on the 19th, the longest wave in Declination attaining an amplitude of 17′.

On September 16 the group extended from longitude 66°, north latitude 10°, to longitude 42°, north latitude 16½°.

THE SOLAR ECLIPSE OF AUG. 9.—The following is a description of the corona as seen by one of the few fortunate observers, M. Lous, who was stationed on the summit of a mountain, Hegmotind, near Bodö:—"From 350° to 50° and around 180° the size of the corona was 16′. From 50° to 130° or 140° there was an extension of 30′ divided by a radial suppression between 80° and 90° inclined towards the inner corona. From 280° to 350° were two tufts meeting at their bases, nearly at 310°, and both pointed at their exterior edges; the largest extension of one was 36′ between 290° and 300°, the other rose to 50′ between 330° and 340°. The latter was nearly vertical. Three red prominences were seen at 75°, 100°, and at 280°, the last being visible to the naked eye. The above numbers are only approximate." The above is a translation in 'Nature' of a communication to Ast. Nach. No. 3378, by Prof. Geelmuyden.

Baron Kaulbars, of the Russian Expedition, who occupied a station in Russian Finland, and was also favoured with a clear sky, reports an unusually large development of the corona. He states that one extension was about double the length of the solar diameter.

The two Garnet-red Spots on Jupiter.—Herr Leo Brenner writes to us with respect to Mr. Denning's article in our last number as follows:—"Allow me to state that these spots were drawn by me on 1894 Sept. 20, and that the peculiarity of their rotation for the period 1894 Sept. 20 to 1896 June 8 was determined by me from about 80 micrometer measures and transits. I found that the 'violin spot' and the 'garnet spot' were identical with certain spots which I observed in 1894 and 1895, in preparing a report on my observations of Jupiter which will shortly be published by the Vienna Imperial Academy of Sciences. In that paper there is given details of the rotation from about 200 other spots, as well as of these garnet-red spots, and the report will also contain six micrometer measurements of the belts and bands of the planet illustrating the curious variation of their latitude.

"Mr. Denning will, I think, probably be disappointed in his hope that the garnet-red spots will be observed during the next apparition, for when I observed them in June, the violin spot was nearly dissolved, and the garnet spot quite pale. I fear that both have already disappeared, but we may hope to see other similar garnet-red spots, as that latitude produced more than a dozen of them during the apparition 1894–1895."

Herr Brenner also tells us that from his observations he infers that the rotation of Uranus cannot be far from 8½ hours, and that a slow rotation of Mercury is an impossibility, and that this latter planet rotates in a period not far from 33 or 35 hours. He promises to give details in subsequent numbers of the Ast. Nach.

The International Catalogue of Science.—In our August number we published some of the resolutions passed at the Conference which met to discuss the making of a complete Catalogue of scientific literature. We have as yet seen no account of the proceedings nor of the schemes proposed, but it is possible that the discussion resolved itself into this question: shall the Catalogue be absolutely alphabetical, or shall it be arranged in sections under subject-headings? If the first of these plans were chosen the selection of the catch-word from the title of a paper is obviously important. No doubt more than one catch-word would be chosen and the paper indexed in more than one place, and this improves this method; but the disadvantage is said to be that so many dissimilar subjects come into juxtaposition—Transits of Venus with Venus's looking-glass, Phases of Mercury with mercury oxide. If the other method were adopted the question arises, Shall each subject be subdivided according to its branches? *e. g.*, Shall Astronomy be divided into Geometrical and Physical, and these again into subsections? The advantage of subject-division seems to be that a person interested in one subject has it all catalogued in small compass; but the opponents of this method say that no two persons would classify alike, and that different sciences are so interwoven, Electricity with Magnetism, Astronomy with Optics, that it is impossible to separate them. Also they say that the advance of knowledge alters the boundaries of any particular science, as is exemplified by the fact that Optics is now coming into the domain of Electricity, and that by making a Catalogue on this plan we should be merely setting up "a monument of contemporary ignorance." The scheme which the Conference seems to have adopted of printing and circulating slips bearing the titles of all works as they appear, seems good as combining some advantage of both systems. A worker in any particular science can procure the slips relating to his branch (though the difficulty of selection with a view to the future comes in here), and arrange them strictly alphabetically, or in subdivisions as he pleases. The arrangement in the bound catalogue is not an easy matter to settle to please everyone, and the Conference has done well to leave it for further consideration.

THE COMPANION OF SIRIUS.—A telegram from Kiel states that the very faint companion to Sirius has been again observed, this time by Dr. T. J. J. See at the Lowell Observatory, Arizona. The existence of this star was inferred by Bessel from the observed non-uniformity in the proper motion of the bright star, and his conclusion that Sirius was actually a binary was confirmed by the observation of the companion by Alvan Clark, Jun., in 1862. This star is not faint by reason of its small size, for from dynamical considerations it is believed to be of about half the mass of the primary star, whilst its light is only about $\frac{1}{10,000}$th. The period of revolution is about 50 years.

LARGE METEORS.—Two brilliant meteors appeared on the night of September 10, and were observed by many persons. The first became visible at $9^h\ 3^m$, and to observers at Exmouth, Yeovil, Bristol, and other places in the S.W. part of England seemed much brighter than Venus, and traversed a path amongst the stars of Ursa Major in the N.N.W. sky, where it left a bright streak for about 30 seconds. It was directed from a radiant near *α* Aurigæ. The second appeared at 10^h 26^m, and was so brilliant that it quite illuminated the sky for several seconds. It was seen at Southampton, Isle of Wight, Bridgwater, Bridport, Yeovil, Bristol, London, and many other places. Its real path seems to have been over Herefordshire, where it descended from an elevation of 71 to 30 miles, and its apparent radiant was at 330° +71°, or slightly east of *β* Cephei.

MEASURES OF JUPITER'S DIAMETER.—Prof. Schur, with the Göttingen heliometer during the period 1891–96, has made determinations of Jupiter's diameters and obtains a mean result of 37''·42 for equatorial, and 35''·13 for polar diameter. This is practically the mean value of the best determinations with the heliometer, and is 1'' less than the best values with the filar micrometer.

THE NOVEMBER METEORS.—It is not too soon to call attention to the fact that observation of outlying members of the Leonid group of meteors may be made this year on Nov. 14 and 15 and a few days before and after these dates. Dr. Johnstone Stoney called attention to the importance of making accurate observations of these this year in a valuable paper in the 'Monthly Notices' of June last. We shall hope to revert to this subject in our next number, but here we may state that Mr. Edney, of the Meteorological Department at Greenwich, is preparing star-charts of the region of observation, a copy of which he will be glad to send to any applicant.

THE WETTEST SEPTEMBER ON RECORD.—In the popular mind, September holds an excellent record for fineness, and there have been many Septembers in which this character has been well borne out, such as the ideal September of last year, and that of 1865 when there was only one rainy day. At times, however, September shows that it possesses in a minor degree the rainy characteristics of the other autumnal months, rivalling in this respect the wet month of October, as has been the case this year, when the long-continued drought which had prevailed during the earlier part of the year pointed to a probability of excessive autumnal rains. The rainfall in the month of September this year has amounted to 5·54 inches, which is the largest September rainfall registered at Greenwich since the commencement of authentic record in 1841. It ranks also as ninth in the list of large monthly falls, having been exceeded in amount three times in October, twice in July, and once in each of the months of June, November, and December. Previous instances of large rainfalls in September have been 4^{in}·12 in 1871, 4^{in}·00 in 1880, 3^{in}·99 in 1842, and 3^{in}·95 in 1841. Notwithstanding this heavy September rainfall, the total for the first nine months of the current year is still 2¼ inches below the average.

THE obituary for the past month includes the name of M. Hippolyte Fizeau, the eminent physicist, whose name is inseparably connected with the determination of the velocity of light. The deceased gentleman was 77 years of age. The death is also announced of Signor Luigi Palmieri, Director of the Vesuvius Meteorological Observatory. Signor Palmieri, who was born in 1807, has invented several instruments of a meteorological nature, and done much work in that science.

MISS CAROLINE W. BRUCE, of New York, has added to her many donations to Astronomy by a gift to the Lick Observatory of a sum of money to buy a comet-seeker and photometers. Mr. W. W. Law has also made a liberal donation to the same institution to help to defray the expense of publishing the Atlas of the Moon.

WE are glad to see that Dr. Doberck has found time to again take up the observation of double stars. A recent contribution from him in Ast. Nach. No. 3378, consists chiefly of measures of southern stars.

WE hear that the opening of the Yerkes Observatory, which was to have taken place during the summer, has had to be deferred, owing to delay in completion.

IT is announced that M. Folie has resigned the Directorship of the Brussels Observatory, which post he has held since 1885. This step is due to reasons of health.

MESSRS. HUSSEY AND HOLDEN, at the Lick Observatory, observed a bright prominence on the terminator of Mars on August 27.

ERRATA.—P. 305, line 17, *for* "Struych" *read* "Struyck." P. 332, line 3, *for* "Neothenus" *read* "Neoterius."

FROM AN OXFORD NOTE-BOOK.

A RAINY day is a good time to write notes. It has been raining steadily since noon yesterday, and seems only now to be getting really interested in the business. But we are not ungrateful for a pause in the continuous labour of the last ten days, and two other rainy mornings that we had produced beautifully clear afternoons. Indeed, we feel that we should not be very sorry to have it raining hard on the Eclipse morning—now only ten days hence—though, perhaps, we are over-estimating the philosophy of our temperaments. Personally, I have not yet tried an afternoon eclipse, and do not know what it is to watch the weather under such circumstances through a long morning, though I have vivid recollections of two restless nights, one of which was followed by a satisfactory event, and the other was not, and I still remember the terrible feeling of depression consequent upon the latter. How does a cloudy eclipse compare in this respect with the Influenza? If it is cloudy on August 9, I don't fancy it will be very easy to write anything afterwards about our doings, and so I may as well put down something now.

We left Tokio for a glance at Nikko and its temples, where we played the usual game of buying things from "merchants" with great enjoyment, and had a delightful day's walk to Chusenji with two fellow-passengers from the 'Empress,' who turned up propitiously. An incident connected with the expedition is worth recording. Our friends, being at another hotel, had dined with us the night before at ours, and were good enough to commend the dinner, not only to us, but to the landlord of their own hotel, to whom they pointed out the desirability of treating us equally well when we returned with them the next evening. I wish I could do justice to the result! When the other diners had finished their coffee and dessert we had only got about a third of the way down the menu, and the landlord was personally bringing up relays of "musŭmes" bearing new and most excellent dishes, with a determination which for some time we dared not oppose, though at last we were fain to cry "Hold! enough." He quite won *that* game.

On Monday, July 13, we embarked on H.M.S. 'Humber' for Akkeshi, the selected station in the northern island of Yezo or Hokkaido, which we reached on Thursday, July 16. The British fleet was already in the bay when we arrived (H.M. ships 'Centurion,' 'Rainbow,' 'Narcissus,' 'Immortalité,' Pique'; later the 'Alacrity' and 'Undaunted'), and as soon as we were within signalling distance the Admiral (Sir Alexander Buller) invited us to dinner on the flagship. We learnt that the fleet had been kept outside the bay for 36 hours by fog, which had only cleared a few hours ago, so that our journey (though not without experience of fog) had been a lucky one. The next morning the fog was again thick, though, on landing, we found that it was a sea-fog merely, and did not extend inland. We first enquired for the other astronomers. Professor Schaeberle and party we found established at one of the Japanese hotels, with their instruments mounted in the yard, much as we had formed the intention of doing ourselves. Mr. Hirayama was further round the bay, and we visited him in the afternoon; but as there was another hotel vacant, with a commodious backyard, we struck a bargain at once with the help of the officials, who were befriending us, and returned to the ship to lunch, feeling well satisfied.

Fog prevented our landing the instruments next day—the sampan, or flat-bottomed boat, which we had engaged to bring them off was trying for 4 hours to find the fleet and failed. The distance from shore was about 2 miles and the fog very thick ; but the failure so disgusted the Governor of the District, who had taken all our arrangements under his personal supervision, that he came off himself the next morning in the sampan to see that the utmost was done, and arrived at 6.30 A.M. Being Sunday we were mostly asleep, but we responded to this display of energy as promptly as possible; were all ashore by 11 o'clock, and by dinner-time had made a good start in putting up huts before the eyes of astonished natives. The work has proceeded at a fair pace, and we are now at the stage of final adjustments. Our three huts in their enclosure (necessary to keep away dogs and fowls) are in full view as we sit, and are apparently standing the rain well. A local Japanese artist has painted dragons and gods and the zodiacal signs all over them, and the wetting has not affected his work at all. Still we shall not grumble when it stops raining.

WE have found the Japanese quite as delightful as they have been so often described. This is only a little fishing-village of course, but it has been very good to us, from the Governor downwards. The Chief of Police is specially protecting us ; a rich merchant next door helps in numerous ways, and is hoping to lodge the Astronomer Royal, when he arrives, in his own house. There is a fine old Japanese gentleman living on the hill, who was once a Samurai and never drew his sword without killing his man; now he manufactures iodoform from seaweed, and has amassed enough money during the war to build a new house. He and his married daughter have the most beautiful manners, and they send us gooseberries and herrings, and the kindest messages—as, for instance, that they were so sorry to think they could do so little for us, but perhaps it might be useful for us to know that they had a servant who could starch linen. It may seem a trivial matter in print, but let those who have never had to contemplate a gradually diminishing stock of clean shirts beware of under-estimating its value. We had a few of these excellent people to dinner, and enjoyed ourselves immensely. So did they.

WHEN the Captain of the 'Humber' was on shore the other day our interpreter (an invaluable man, by name Ishikawa) brought him up a telegram. It was on an open sheet of paper, but we were by this time accustomed to Japanese publicity, and therefore not much surprised, and the Captain said there would be no answer. But Mr. Ishikawa explained that the messenger was not waiting for the answer as yet, but only to know "if it was all right"; for if it was, he would take it back and bring it in an envelope in the proper way. The paper was accordingly returned to him, and in about twenty minutes (the Post Office is about a hundred yards away) he returned with an official envelope, in which was the official telegraph-form with the message as before; he presented an official receipt for signature, and was officially informed that there would be no reply. This is undoubtedly the way to avoid making official mistakes—have a rehearsal.

COL. RIVERS and one of the naval officers went a ride the other day to Shibecha. They found it further than they thought and were fain to stay the night there, but they had forgotten to take their passports and the police were dubious. After some time a Japanese Missionary was found who could speak a little

English, and the situation was explained to the best of this interpreter's ability. Col. Rivers took care to mention that he was in Japan to see the eclipse, but this did not seem to produce much effect at the time. By 5 o'clock the next morning, however, some glimpse of his meaning had been caught: the Chief of Police, accompanied by a telegraphist accustomed to grapple with English, called upon the travellers and made them a long speech. The telegraphist had all the hard words written out on a piece of paper, which he consulted when necessary, and said that all the police officers in Yezo had been given orders to be particularly kind to foreigners come to see the eclipse "for cause of Skiences"; and the present Police officer would do anything he could for them if only they would allow him. He said ordinary folk required passports, but they were quite exceptional, and they must forgive his oversight. This treatment is quite characteristic. The Japanese have done their very best for us throughout.

PROFESSOR SCHAEBERLE'S establishment is just a drive and an iron away. [My poor golf-clubs have not been taken out of their case: I never saw a more abjectly hopeless country for the game.] In his backyard Providence or an earthquake has placed a rock, which just suits his forty-foot telescope to lean against. The tube is pointed up it to the exact spot which the Sun and Moon will occupy on August 9 at totality time, and on the top of the rock wave the Stars and Stripes. At the bottom of the tube is the small tent in which Professor Schaeberle will expose his 22 × 18 in. plates (a four-inch image of the Sun) and in which he was prepared to sleep if necessary. The intervention of Providence is clearly manifested in that the base of the rock in other azimuths is occupied by a pond, in which croak three frogs with a mighty croak. They have been called by the genial Americans "the Akkeshi band"—though a much better performance may be heard in the hotel, from a young lady who sings and plays the Japanese banjo. Mr. Burckhalter has his big photoheliograph (with the spinning arrangement for varying the exposure for different parts of the corona) on the other side of the rock; and two other friends make up a very happy party.

MR. SHIN HIRAYAMA of Tokio is about a mile away round the bay. To reach him one must, moreover, ferry across the mouth of the lagoon, which opens out of the bay and is full of oysters. The oysters are not very interesting at this time of year, from the gastronomic point of view, though we liked being shewn the oyster-beds and the experiments of a naturalist who is trying to make artificial beds. To get across the ferry one pays two sen to an Ainu lady with the coral of her lips tattooed a fine blue; and takes one's seat in a big sampan. (The horses stand up.) On the other side, after passing one or two acres of fish rotting for manure, a short walk brings us to Mr. Hirayama's hotel. He is an old friend, having been at Greenwich for some time a few years ago;

and makes us very welcome. He has also set up a forty-foot photoheliograph, but in the horizontal position with a siderostat at the end. His plates are even bigger than Professor Schaeberle's (24 × 20), but he has made excellent arrangements for manipulating them, and seems altogether comfortable and prepared for the best. We had a long chat about his particular form of siderostat, but any reference to this must be deferred for the present.

A LARGE number of dictionaries and treatises on the language have been constructed for the guidance of those wishing to learn Japanese, but none of them seem to me very compendious. There is a tendency to aim at completeness which leads to the introduction of phrases not often required; such as: "I will lie down a bit, as I feel sea-sick."

Japanese: *Fune ni yoimashita kara, chotto nemashō.*
Literally: Ship in have-got-tipsy because, little will lie.

Having spent some time in committing to memory this and other phrases which I was never able to use, I venture to put down the really necessary words and phrases, so that others may not be put to needless trouble:—

Ohayo! = Good morning (at any time of day).
Tabetai = We are very hungry, please get dinner ready.
Hayaku, hayaku = Please hurry up!
Biiru des ka? = Have you got any beer?
Biiru des = Yes, we have, very good beer.
Yoroshii! = Good!
Motto des ka? = Is there another course coming?
Motto arimasen = The menu is finished.
Ikura? = How much to pay?
Sayonara = Good-bye.

THIS note is pencilled at local midnight preceding the eclipse. Half my slides are filled (the operation of filling when complicated by "backing" the plates and putting on "standard squares" is not a rapid one) and the dark-room is now occupied for a time by the Astronomer Royal. We are pretty cheerful, for the day has been brilliantly fine. Last night a day of gloom and fog had left its unmistakable mark upon our spirits; but since 7 this morning we have been as busy and merry as bees in full sunshine. The final rehearsals have gone without a hitch, the officers and men of H.M.S. 'Linnet,' which brought the Astronomer Royal and has stayed by us, performing their evolutions like clock-work. H.M.S. 'Pique' has arrived in the bay and will take us off on Tuesday, and H.M.S. 'Alacrity,' with Admiral Buller on board, is expected to-morrow morning. We had a great crowd of visitors to watch our rehearsal, and the little Japs are never tired of mimicking the steady "one, two, three" of the time-caller. In fact after a good deal of hard work we are all ready. And now what is to-morrow to bring forth?

It is all over! This note might have been written during totality for all the good we did. The morning of August 9 was cloudy and foggy. We had all put the final touches to our apparatus and had nothing to do but wander about in a state of suspense. The fog seemed to grow thinner and at noon the Sun's disc shone through. It was more or less visible until the partial phase was well advanced, when the fog shut down finally. Not a gleam of anything was seen during totality. In an hour or two came a telegram from Esashi saying that the Corona had been "faintly visible, several plates exposed"; but other telegrams followed, showing that the bad weather had been widespread, and it seems pretty certain that the Japanese expeditions have drawn blank. We packed up with feverish haste and were on board H.M.S. 'Pique' on Monday afternoon and at Yokohama on Thursday. Since then we have been trying to forget our disappointment in the distractions of shopping and sight-seeing.

Turning over the leaves of a story-journal on August 10, the following caught my eye:—

> When George IV. arrived in the Leith Roads on his visit to Scotland, the rain poured down in such torrents that Sir Walter Scott was deputed by the citizens humbly to request his majesty to postpone his debarkation till the next day, which he did in the following amusing speech:
>
> "Impatient, sire, as your loyal subjects are to see you plant your foot upon their soil, they hope you will consent to postpone your entry till to-morrow. In seeing the state of the weather, I am myself forcibly reminded of a circumstance which once occurred to me. I was about to make a tour through the Western Highlands with part of my family. I wrote to the innkeeper of a certain hostelry, where I meant to halt a day or two, to have rooms prepared for me. On the day appointed it rained as it does to-day, unceasingly. As we drew near our quarters, we were met on the hill over his house by our Boniface, with bared head, and backing every yard as I advanced, who thus addressed me:
>
> "'Gude guide us, Sir Walter, this is just awful! Siccan a downpour! Was ever the like? I really beg your pardon. I'm sure it's no fault o' mine. I canna think how it should happen to rain this way just as you, o' a' men o' this warld, should come to see us. It looks amaist personal. I can only say, for my pairt, I'm just ashamed o' the weather.'
>
> "And so, sire, I do not know that I can improve upon the language of the honest innkeeper. I canna think how it should rain this way just as your majesty, of all men in the world, should have condescended to come and see us. I can only say, in the name of my countrymen, 'I'm just ashamed o' the weather!'"

When the sharp sting of disappointment is over, one is fain to admit that there have been many conpensations. We have had a most delightful trip in many ways: seeing Canada and the Pacific, and wondrous Japan; and last, but not least, we have seen something—a very little it is true, but still far more than most people—of H.M. Navy. We asked the Admiralty for a ship to aid the expedition; but circumstances so ordered it that we have had the help of almost a fleet! We have grateful recollections of the 'Humber,' which took us to Akkeshi, the 'Linnet,' which helped us there, and the 'Pique,' which brought us back. The officers and men of the 'Linnet' learnt their parts so quickly, that the rehearsals went without a hitch from the second day. Moreover, they shot us a duck, and gave us a concert on board. We shall not easily forget the entertainment: the rigging draped with flags, the picturesque grouping of the men with the lamp-lights flickering on their faces, the cheery humour of the singing to a skilful harmonium accompaniment. Captain "Bobby" Sparkes and his ship are now off to the Behring Sea for two months, and he takes our very best wishes with him.

It will be remembered that Mr. Charles Burckhalter has proposed a method of exposing plates to the corona which, if not new in principle, is at any rate new in application. By means of a revolving disc placed in front of the plate and cut into a peculiar shape the exposure which any part of the corona receives is graduated in some inverse relation to the brightness, the aim being to secure pictures in which the faint outer corona is shown, while the bright inner is still not too much over-exposed. We paid a visit to Mr. Burckhalter one morning and saw his apparatus; and we greatly admired the skill with which he has overcome the difficulties obviously attending such a project. To describe his apparatus here would take far too long, but I am glad to be able to set down these few words of appreciation for what they are worth. Mr. Burckhalter must have spent an immense amount of time in arranging the details, and had no subsidy of any kind. His disappointment must have been specially severe; and I sincerely hope he will have another chance with better luck. What big stakes one plays for in this eclipse game!

There is a legend extant in Japan of an eclipse which occurred a thousand years ago. Two eminent astronomers, A and B, of the same nationality, arrived about the same time, and their instruments were received for examination by the customs authorities in the same building. Both A and B were equally anxious to minimize any delay; but while A took very energetic measures to this end, visiting countless officials with letters of introduction, and hiring an army of coolies to carry out the instruments when it should be allowed, B was content to await events. In course of time, A's efforts were crowned with success, and the coolies went to work; but when they reported the removal accomplished, and A went to inspect the result, he found that they had got out B's instruments by mistake! Moreover, B had apparently been on the spot, and had seen the transaction, but, as he explained apologetically to A, he had been unable to stop it, not knowing any Japanese.

On August 20 M. Deslandres gave a very pleasant dinner at the Club Hotel, Yokohama, at which we met the officers of the French man-of-war 'Alger,' and also Professor and Mrs. D. P. Todd. The 'Alger' had taken M. Deslandres from Yokohama to Esashi, and had brought him back, giving a passage at the same time to Prof.

and Mrs. Todd. We learnt that the corona had been seen through cloud at Esashi, and some plates had been exposed, but we did not gather that much was thought of the result. The next day we lunched on board the 'Coronet,' the yacht which had brought Professor Todd's party to Yokohama, and came to the conclusion that the journey must have been most enjoyable. From the 'Coronet' we were put on board the 'Empress of China,' homeward bound.

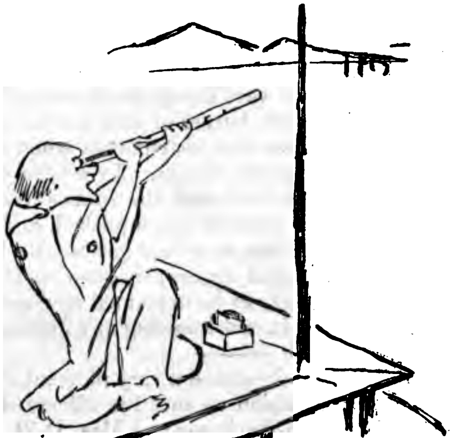
THE following extracts from a Japanese guide-book afford some curious examples of inference:—

"The breadth of the waterfall is estimated at about 12 feet; but as the visitors cannot approach to the base of the waterfall, on this account its exact size cannot be obtained." * * * * * *

"One branch of the cave is at least fifty yards deep, the other has only been once explored. A man went in one morning and came out next day, from which it is calculated that the length must be at least 23 miles." * * * * * *

"On the right-hand bank of the stream are several hundred images of Buddha ranged in a long row, the exact number of which is unknown. They always count up differently, however often the attempt is made; and even the expedient of pasting a slip of paper on to each one, so as to be quite certain of making no mistake, is useless."

IN Japan the scenery is good, both human and landscape; also manners, woodwork, ornamental work of various kinds, the large hotels, and climate may be commended. Matches are bad, often breaking or fizzling out; and the same may be said of promises, both human and meteorological.



THE OBSERVATORY,

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The Leonids.

The dense part of the Great November swarm of meteors will in 1899 return to the node of their orbit, the place where their orbit intersects the Earth's path. The Earth comes round to this point about the middle of November in every year. The head of the stream will probably reach that position in the latter part of the spring of 1899; and if so, the Earth will pierce through the mighty stream, which takes more than two years to pour past the node, in the following November, in November 1900, and perhaps also in November 1901. Transits of this kind have been going on for centuries, and on each such occasion a few millions of the meteors are intercepted by the Earth, and produce the splendid displays which are seen on such occasions, and a few more millions pass close enough to the Earth to be diverted from the meteoric orbit into others slightly different. Meantime the countless hosts that escape the Earth pursue their course undisturbed, each meteor moving independently of the rest. Their periodic time in their orbit is 33 years and a quarter, so that the great swarm revisits the Earth three times in a century, and on each return of this kind the Earth passes more than once in successive years through the meteoric stream, scattering some of its members in the way described above. After the Earth has passed, those Leonids that have been influenced by it find themselves with periodic times slightly differing from that of the main stream, and this causes them gradually to distribute themselves round the whole orbit, so that the Earth encounters a few of them every year, even in those years when the main body is in a distant part of its orbit.

Now, observations of these scattered Leonids are of very subordinate importance, except in the solitary case of Tempel's comet, which is probably one of them. Nevertheless it is not impossible that observations can be made in the present month which may prove to be of exceptional value. It is quite possible that the genuine main stream may be more drawn out in front than we are yet aware of, and that some of the foremost of the procession may reach the Earth's orbit long before the spring of 1899. If so, observations of these will be of the greatest theoretical importance. It is even not useless to be prepared for the possibility that the Earth may encounter some of them in this present year. If so, they will manifest their presence about the middle of the month by being more condensed than the sporadic Leonids seen every year, and by the much greater definiteness with which they come from one radiant-point, which will lie near that point in Leo whose right ascension is 149° and whose north declination is 23°. The Earth will only take about five hours to pass through the advanced part of the real procession, whereas it will encounter sporadic Leonids on several successive nights.

The great majority of the observations made in 1866, 1867, and the few following years were of little value; but fortunately a few astronomers were alive to the importance of obtaining the data which could be made use of in subsequent calculations. These useful points are the longitude of the node of the orbit, and the position of the radiant-point of the meteoric shower; observations of the former are easy, as it is given by the time of the shower, and these astronomers therefore directed their efforts towards ascertaining the radiant-point with precision. But, in the absence of the photographic appliances which we now possess, the result was far short of what was desirable. The following are the determinations made use of by Professor Adams in the marvellous computation by which he ascertained the orbit of the Leonids, and they are probably as good as could then be secured:—

	Position of radiant-point.	
Observer.	R.A.	Decl.
Adams	148° 50′	22° 10′ N.
Baxendell........	149 33	22 57
Brünnow	150	22
Challis	149 39	23 12
Herschel	148 9	23 48
A. Herschel......	149	24
Mean....	149 12	23 1

It will be observed how much these differ and how much they therefore fall short of the accuracy we may now hope to attain by photographic methods. The following extract from a letter with which General Tennant, F.R.S., F.R.A.S., has favoured the writer gives the best guidance to observers with which he is acquainted:—

"Suppose an ordinary camera with a good wide-angle lens, which will admit of a considerable aperture being used over the whole plate, to be mounted equatorially, pointed to the radiant of the swarm as nearly as possible, it would of course depict, as lines, the courses of all the principal meteors which passed before it, and as points the principal stars; it would be thus easy to find the radiant with some accuracy. I would fit up the camera with a roller slide, and its continuous film, and the exposed surface could then be changed frequently at regular intervals, and the film should be developed (as I believe it can be) without being cut, so as to ensure that there was no change in the succession of the images. A continuous watch would thus be kept on the neighbourhood of the radiant for as long as necessary without any very great tax on the observer, whose only business would be to traverse the film at the proper times. Of course the number of cameras might be multiplied if thought necessary, and each be directed to a different part of the sky; but, while these would extend the area of registration, it would not be so easy to carry back the traces to the radiant. Probably one of the Cooke lenses, invented by Mr. Dennis Taylor, F.R.A.S., would give the best means of observing a wide field. I do not think that the focal length need be great, as a very moderate scale would give far more accuracy in the individual tracks than we have yet seen; but that is to a great extent a question of expense and convenience."

The two points to be determined are the longitude of the node of the orbit and the radiant-point of the meteors as they enter the Earth's atmosphere. The first is easily observed, as it is determined by the time when the shower occurs. Both the time it begins and ends should be noted, and if portions of film are successively exposed, as General Tennant suggests, the time of beginning and ending each exposure should be recorded. The only satisfactory way of determining the radiant-point is by the photographic method.

It is of much theoretic importance that these two determinations shall be made in each of the years that the shower presents itself; for if, as seems probable, the stream of meteors does not lie accurately along the main orbit, this fact will be brought to light by the observations: and it is probable that mathematicians will be able to extract information of great interest about the past history of the Leonids from a study of the cause of any deviations that may be observed. For this purpose, observations on the extreme front and the extreme rear of the stream are obviously of special value. Hence it is that if any opportunity occurs this year it should not be lost.

The orbit, as determined by Professor Adams, was in 1866:—

Period	33·25 years (assumed).
Mean distance	10·3402
Excentricity	0·9047
Perihelion distance	0·9855
Inclination	16° 46′
Longitude of node	51 28
Distance of Perihelion from node.	6 51

Motion retrograde.

This orbit seems to intersect the orbit of Uranus. By the better observations which we may hope to see made within the next few years, it can probably be ascertained with certainty whether the two orbits do intersect. Again, there is reason to suspect that the meteors and the great planet Uranus were both at or very near the point of intersection of their orbits in the end of February or beginning of March of the year A.D. 126. We may hope also to ascertain whether this was so. Further, the meteor stream is slowly lengthening—a process which must have at some time begun. We may, if sufficiently accurate observations can be made, hope to ascertain, or to lay the foundation for ascertaining, when this lengthening out process began. If it should turn out to have been 1770 years ago, Le Verrier's surmise that the swarm was a compact cluster previous to A.D. 126, and that in that year it came across the planet Uranus, and was by it drawn into the Solar System, will be abundantly confirmed.

Owing to precession, and to the perturbations which the Leonids suffer from the planets, the heliocentric longitude of the node, which in 1866 was 51° 28′, is increasing on the average by $102''\!\cdot\!6$ annually. This average does not take account of nutation, nor of the inequalities in the rate of shift of the node. Nutation may be left out of account, as it could only affect the time of the Earth's reaching the node by something less than 8 minutes, which, in dealing with a phenomenon that lasts five hours, we need not regard. But the inequalities in the rate of shift are of more serious import. They and the uncertainty in the older observations as to what epoch during the shower is that which was recorded, make the deviations from the times, calculated on the hypothesis of a constant shift, average about 7 hours in the 14 recorded observations (14, if we may suppose the meteors seen in A.D. 931 to be Leonids, which seems doubtful), and on one occasion (in A.D. 1533) it amounted to a whole day. In 1866 the observed longitude fell short of the calculated by 18′, an angle which the Earth describes in about 7 hours. Adding, accordingly, 18′ to the observed longitude in 1866, and allowing for a constant shift since of $102''\!\cdot\!6$ annually, we find for the computed time of the middle of the shower this year (if the front of the stream has reached the Earth's orbit) the following value:—

1896 November $13^{d}\ 23^{h}$,

with an equal probability that the actual time will deviate from this by any interval up to 7 or 8 hours, and a possibility that the deviation may be greater.

Hence a watch should be kept from at least midnight on the 13th till near midnight on the 14th. The Moon will be absent in the morning hours; and, if the shower occurs in the evening, when the Moon will shine, many of the meteors are so bright that some are likely to be visible both to the eye and in a photograph. Of course it is uncertain whether the stream extends far enough in front to reach the Earth at all this year.

A better determination of the time of the return of the meteors might be obtained by taking Adams's orbit and computing the actual perturbations it has suffered from Jupiter, Saturn, and Uranus during the revolution of the meteors since 1866 which has now been nearly described.

It would also be very desirable to form an ephemeris of the position of the swarm in space, so that efforts may be made during the next few months, when the swarm will be in its best position, to get a photograph of it. The densest part of the swarm at present lies to the north of the interval between the orbits of Jupiter and Saturn, or slightly farther out; and as it is about 100,000 miles across, it is quite large enough to be visible on a photograph, if not too faint.

APPENDIX.

The following list of papers about the Leonids will be useful to anyone who wishes to consult the original sources of information:—

Two important memoirs by Prof. H. A. Newton will be found in 'Silliman's Journal' for 1864, vol. xxxvii. p. 377, and vol. xxxviii. p. 53.

The result of Professor Adams's splendid investigation was announced in the 'Comptes Rendus' of the Academy of Sciences of Paris, of the 25th March 1867, p. 651; and a fuller account of it will be found in the 'Monthly Notices' of the Royal Astronomical Society for 1867 April, p. 247.

An account of Signor Schiaparelli's contribution will be found in 'Les Mondes' for 1866 December and the first quarter of 1867. An outline of them in English, from the pen of Professor Newton, will be found in the 'Philosophical Magazine' for 1867 July, p. 34.

M. Le Verrier's communication was made to the French Academy of Sciences, and is published in the 'Comptes Rendus' of the 21st January 1867, p. 94.

A paper by the present writer will be found in the 'Monthly Notices' of the Royal Astronomical Society for 1867 June, p. 271; and in the 'Philosophical Magazine' for 1867 September, p. 188.

In 1879 Professor Newton delivered in America an interesting lecture on "The Relation of Meteorites to Comets," of which a report is published in 'Nature' of the 6th and 13th of February 1879.

A discourse by the present writer, in which a general survey is taken of the whole body of discoveries which were made in connection with the last visit of the November meteors, is reported in the 'Journal of the Royal Dublin Society' of 1869 April 3, and in the 'Proceedings of the Royal Institution of Great Britain' of 1879 February 14.

G. JOHNSTONE STONEY.

Remarks on the Progress of Celestial Mechanics since the middle of the Century.

[Continued from p. 358.]

In 1890 was published the memoir of M. H. Poincaré, entitled 'Sur le problème des très corps et les équations de la dynamique,' and which obtained the prize of the King of Sweden. Most of the results of this memoir were worked over and presented anew with greater elaboration and clearness by their author in 'Les Méthodes Nouvelles de la Mécanique Céleste.' Here we find a large number of new and very interesting theorems.

First is to be noted the class of particular solutions in the problem of the motion of a system of material points which are now named *periodic solutions.* The initial relative positions and velocities of the several points are so adjusted that, after the lapse of a definite time, the latter retake them. Hence is evident a method which may be employed to elaborate this special case of motion, viz. by the tentative process with mechanical quadratures. M. Poincaré has divided this sort of solutions into three classes, of which, however, the second and third are not essentially different. He has shown that, in the latter classes, the values of the arbitrary constants of the problem must be so adjusted that no secular inequalities, or, as Professor Gyldén calls them, elementary terms, may arise. The number and variety of these particular solutions is far greater than one would at first sight imagine.

We come now to a second class of particular solutions named by the author *asymptotic.* It arises from the consideration of solutions differing very little from periodic solutions. Here we have to deal with linear differential equations having periodic coefficients. The integrals of these contain in their terms exponential factors, and on the nature of the exponents of these factors depends the quality of the resulting solutions. M. Poincaré has named these exponents *characteristic.* They are roots of an algebraic equation of a degree equal to the number of dependent variables involved in the question. If any of these roots are imaginary, with real portions or wholly real, we are in presence of asymptotic solutions. The algebraic equation mentioned contains the unknown only in even powers: hence the characteristic exponents are in pairs having the same absolute value, but with contrary signs. In all the cases presented by astronomy, where, on account of the near approach to circular motion, a periodic solution can be taken as a first approximation, it appears that the squares of the characteristic exponents are all real and negative. Thus there is no call here to consider this sort of solution, and this fact must much diminish the interest of the astronomer in it. M. Poincaré has, however, elaborated it with great pains, showing how the effect of higher powers of the deviations from the periodic solution may be taken into account. The series resulting are, nevertheless, divergent, as in other cases.

The second volume of the 'Méthodes Nouvelles' is devoted to the elaboration and consideration of various processes for developing the integrals of planetary motion according to the powers of a small parameter. The chief of these are due to Professor Newcomb and MM. Lindstedt and Bohlin; but M. Poincaré has augmented the number of them by introducing modifications of his own. All involve the principle of recurrence: that is, the first step is the only one which is independent, the following depend on all that precede. These methods, in their general aspect, do not differ from the old developments in powers of the disturbing force, except the operations are so adjusted that the time never escapes from the trigonometric functions. This is accomplished by greatly augmenting the number of the elementary arguments, and by supposing that the rate of motion of each of these is developable according to integral powers of the before-mentioned parameter, or, in some cases, of its square root.

When there is more than one elementary argument, the series obtained in all these ways are pronounced to be generally divergent in the rigorous sense of the word. M. Poincaré brings forward several methods of proof of this. The first depends on the presence of small divisors in the expressions of the coefficients. However, when we do not insist on developments in powers of a parameter, this method of proof has no application. Another method is derived from the principle that two characteristic exponents vanish for every uniform integral that exists. But the integrals which necessitate this conclusion must not only be uniform, they must be valid for every possible case of the problem. Now the integrals known as those of the conservation of living forces and of areas are of this nature; but the integrals derivable from the series of Delaunay, Newcomb, and Lindstedt are valid only for a limited range in the values of the linear variables. For instance, in the problem of the three bodies, if the deformation of the triangle formed by these bodies is such that we cannot find any two sides, one of which sustains to the other an invariable relation of greater to less, we cannot apply the mentioned series. And here it is well to note that the defect of convergence does not arise from the application of the processes of integration, but already exists in the development of the perturbative function before integration commences. Thus Delaunay's development of this function at the beginning of his lunar theory is divergent and illusory, unless we have the lunar radius in apogee always less than the solar radius in perigee, and that without regard to the mode of expressing the coefficients. Some of the particular integrals, relied upon by M. Poincaré to establish the vanishing of all the characteristic exponents in case we accept M. Lindstedt's series as valid, lie, so to speak, on the boundary of the domain in which these series are convergent.

In the third place an appeal is made to the alleged non-existence of analytic and uniform integrals beyond those already known.

Were this non-existence clearly established it would decide the question on the side where M. Poincaré has placed himself. But, at least as far as the non-existence of integrals of this nature in a limited domain for the linear variables is concerned, the proof given for it is quite defective. This proof consists in ascertaining how these integrals, supposing them to exist, would behave, should we attempt to derive periodic solutions from them. It is difficult to present this matter without the assistance of algebraic formulæ: nevertheless, it may be attempted. Let there be a number of equations whose left members are formed by the product of two factors. When we pass to a periodic solution, one of these factors becomes zero. What conclusion can we draw from each of the thus modified equations? Evidently one of two things: either the remaining factor of the left member is infinite and the right member indeterminate, or it is finite and the right member a vanishing quantity. Now in case we are obliged to accept the first conclusion, were it only but once, M. Poincaré has demonstrated the non-existence of integrals; but, granting that it is proper in every case to accept the latter conclusion, the demonstration fails. Now he declines to consider the latter alternative, saying that he does not believe that any problem of dynamics, presenting itself naturally, occurs where the right members of the mentioned equations would all vanish. But it should be borne in mind that, while they do not vanish in the general equations, the adjustment of the values of the linear parameters required by the passage to a periodic solution may bring about their vanishing. Thus, in the lunar theory, a periodic solution is brought about by making $e=0$, $e'=0$, and $\gamma=0$; the result is the vanishing of every coefficient having any of these quantities as a factor.

M. Poincaré appeals in another place to the fact that the Lindstedt series, if convergent, would establish the non-existence of asymptotic solutions. But this observation is irrelevant for the reason that the domains of the two things are quite distinct. In any case where Lindstedt series are applicable there are no asymptotic solutions, and, where there are asymptotic solutions, Lindstedt's series would be illusory.

We owe much to M. Poincaré for having commenced the attack on this class of questions. But the mist which overhangs them is not altogether dispelled; there is room for further investigation.

G. W. Hill.

On the Level of Sun-spots *.

In spite of the large number of solar theories now awaiting scientific acceptance, our actual knowledge regarding the Sun is decidedly limited, and the mass of statistics regarding its surface that has accumulated in recent years has thus far not greatly clarified our views as to the nature, and still less as to the causes, of the solar phenomena.

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* A paper read at the meeting of the American Association for the Advancement of Science, 1896 August, by Prof. E. B. Frost. (Reprinted from the 'Astrophysical Journal,' 1896 October.)

I desire for a few moments your attention in considering our present knowledge as to the elevation of Sun-spots, and I will state at the outset that in the light of recent observations I shall venture to call in question the venerable theory that Sun-spots are depressions in the solar atmosphere.

In speaking of levels we must proceed from some accepted plane of reference; and the most natural plane, or surface of reference, would be the solar photosphere. Here we are abruptly confronted by the theory of Schmidt, elaborated in a convenient form by Knopf *, according to which the photosphere is merely an optical illusion, produced by circular refraction in the Sun itself, supposed to be a globe of glowing gas without a condensed stratum. Prominences, faculæ, spots, and the granulation are explained as effects of anomalous refractions due to local changes of density somewhere within the gas ball.

This theory, worked out as it is by careful mathematical reasoning, deserves and has received respectful consideration. Nevertheless, in view of the physical improbability of Schmidt's primary assumption that in its outer portions the gaseous mass maintains its state without condensation, the physicist will feel obliged to reject the theory, which also suffers from the fundamental defect of failing to account for the solar spectrum on the accepted principles of physics. Moreover, any one who has with some continuousness studied the phenomena of the solar surface must affirm that he has observed realities, not illusions. The perspective effects on prominences as they pass around the limb, the motion and permanence of spots, the displacements of spectral lines on the approaching and receding limbs, and in fact all the phenomena concerned in the solar rotation, are distinctly contradictory to Schmidt's theory. In dismissing it from further consideration, however, we shall take with us the important inference that refraction within and on the Sun itself may modify in some considerable degree the phenomena we observe.

In illustrating an application of this inference we may digress slightly by citing a theory of spots and faculæ suggested by James Renton in a recent number of 'Nature' †, received while this paper was being written. He advances the idea that a spot and the surrounding faculæ are due to an anticyclonic area (of descending currents) over the photosphere. In consequence of the convexity of the successive surfaces of equal density in the solar atmosphere, the radiation from the photosphere centrally under the anticyclonic area will be divergingly refracted so that it will appear to emanate from a greater area than is actually the case. Hence there will result a deficiency in the intensity

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* Jena, 1893.

† 'Nature,' liv. 317 (1896 Aug. 6).

of the radiation as compared with that from a portion of the photosphere over which the atmospheric pressure is normal and the surfaces of equal density are concentric with the photosphere. At the outer edge of the high pressure area Renton considers that the refraction would cause the rays to converge, compressing into a smaller area of the apparent disk the radiation from a ring of photospheric surface around the "spot," with consequent increase in surface intensity, thereby producing the faculæ. While observers will probably agree that refraction must be much less effective than the general absorption by the affected atmospheric area, Renton's suggestion is nevertheless important as recognizing in a rational way the possible results of refraction.

Reverting, then, from our digression, we shall adhere to the view that the photosphere does exist as a condensed stratum of some stability, granulated perhaps by the friction of overlying atmospheric currents, and we shall employ it as our surface of reference.

In now considering the elevation of Sun-spots with respect to the photosphere we shall be able to avail ourselves of four different lines of evidence: (1) direct observation; (2) the solar rotation; (3) thermal absorption; (4) spectroscopic observations.

The belief that Sun-spots are depressions in the photosphere dates back to the last century, when Wilson of Glasgow asserted this to be the necessary conclusion from observed effects of perspective. Probably most observers have at some time noted cases where the penumbra *appeared* foreshortened as the spot rounded the limb. The writer has been led to re-examine the question of the elevation of spots from the evidence of thermal absorption, and in a paper * before this Section at the meeting in 1892 ventured to account for certain measurements on spot radiation on the ground that they "lie in a higher stratum than the photosphere." Within the past two years a large amount of direct observational material has been adduced by assiduous observers to show the incorrectness of the Wilsonian doctrine.

At the meeting of the Royal Astronomical Society in December 1894, F. Howlett presented to the Society † several volumes of solar drawings which in all represented the devotion of thirty-five years to the study of the Sun's surface, chiefly with a view to determining this very question: are Sun-spots elevations or depressions with respect to the photosphere? Howlett's conclusion is that his direct visual evidence decidedly refutes the depression theory. Indeed, in the rare cases where the perspective effect seemed to displace the (supposed) central umbra towards the centre of the disk, the evidence was by no means necessarily in support of Wilson's view; for it was not proven that the umbra was central when the spot was further from the limb, and hence not subject to distortion by perspective. Moreover, Howlett found his visual observations to be corroborated by an examination he was permitted to make of the Greenwich solar photographs. He asserts that "instead of the penumbra of spots possessing *shelving sides*, sloping down towards the umbra, it (the penumbra) presents a *convex* surface; that is to say, a curve conformable to the general contour of the solar orb." Howlett also cites the names of Spoerer, Perry, Ranyard, and Whipple of Kew, as experienced observers who were satisfied of the incorrectness of the depression theory.

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* A. N., cxxx. 129–146 (1892).

† M. N., lv. 73–76 (1894).

In the 'Monthly Notices'* for 1895 April, Sidgreaves brings the data obtained in the long series of visual observations at Stonyhurst to the support of Howlett's position. Of 187 single tests—of spots suitably situated for use for the purpose—he finds 140 opposed to Wilson's depression theory, and but 47 which might seem to confirm it, although he adds that at Wilson's own "valuation of their testimony, nearly all the 47 witnesses will go out of court." Individual spots are cited by Sidgreaves in which the visual and photographic evidence is convincing as to the elevated nature of the spots. Both Howlett and Sidgreaves refer to the impossibility that notches could be made in the edge of the disk by any ordinary spots, if they are depressions; while notches might occur as spots approached the limb, as was contended by Lalande, Kirchhoff, and others, if spots are elevated masses of gas.

Per contra, however, it should be stated that the careful study of a large number of photographs, made some thirty years ago by De la Rue, Loewy, and Stewart, led them to adopt Wilson's view; and the measurements of Secchi and others, although difficult, were accepted as indicating a depression of the umbra of a few thousand miles below the photosphere.

In summing up this conflicting evidence from direct observation, I believe it must be admitted that the question of elevation of spots is at least an open one, and deserving careful consideration from students of solar physics.

We next examine the evidence afforded by the rotation of the Sun, as determined by the motions of the spots, faculæ, and photosphere itself, availing ourselves for this purpose of the valuable results recently published † by Stratonoff, in combination with the classical researches of Dunér ‡ and Spoerer. Stratonoff had for an object the study of the motions of the faculæ, and he reaches the satisfying result that they exhibit an equatorial acceleration as do spots. I use the word satisfying, since the researches of Wilsing and of Bélopolsky were at variance on this point, as the measurements of the former failed to indicate an acceleration. It is incidentally that Stratonoff brings out the for us important fact that the order of the velocity of rotation is faculæ, spots, surface.

The motion of the surface was obtained with great precision by Dunér from measurement of the shifts (by Doppler's principle) of certain lines of the spectrum of the approaching and receding limbs of the Sun. Hence when we say "surface" we in fact refer to the level at which these absorption lines are produced. These lines were due to iron; hence we further limit our statement to the level of absorption of the stratum of iron vapour producing these lines (λ6301·72, λ6302·72), a stratum that may be reasonably supposed to lie very near the actual photospheric surface.

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* M. N., lv. 282–287 (1896). † A. N., cxl. 113–119 (1896).

‡ 'Sur la Rotation du Soleil,' Upsala, 1891.

The results of Stratonoff, which have more recently been confirmed by Wolfer of Zurich in a memoir just received [*], are more important for our question than at first might appear, since the faculæ have always been admitted to be at a higher level than the photosphere. Now we find that they share the peculiar law of rotation of the spots and surface (iron vapour level), and with numerical values next greater than those obtained for the spots, whose ratation was in turn faster than that of the "surface." Hence it is a logical inference that the level of the spots is intermediate between that of the faculæ and surface [†]. E. B. Frost.

[To be continued.]

Selenographical Notes.

Damoiseau.—One may search in vain in any other part of the Moon's visible surface for a formation which structurally resembles this. We have examples (as in Taruntius, Vitello, &c., &c.) of an outer wall enclosing a concentric inner wall of a much smaller diameter, but in the case of Damoiseau the apparent axis of the inner ring so far from being concordant with that of the outer, as in the above instances, is inclined to it at such a considerable angle, that the abnormal character of the combined ring-plains is apparent at first sight. The accompanying drawing is reproduced from one made 1887, 27 December, 8^h to 9^h, the principal details of which have been confirmed on several subsequent occasions.

The eastern shore-line of the Oceanus Procellarum for a long distance south of Damoiseau is very distinctly defined by an undulating mountain-range whose western slope descends at a gentle gradient to the level of the plain. The western wall of the formation appears to be a continuation of the summit ridge of these heights, which do not extend north of it. At the phase represented in the sketch, two clefts are shown as running down to the plain from near the top of the ridge, the more southerly terminating a little east of the crater marked A, and the other, much coarser (issuing from the northern side of two inosculating craters), dying out on the eastern flank of a low mound. This, I think, is Neison's η. The other is not shown in the maps.

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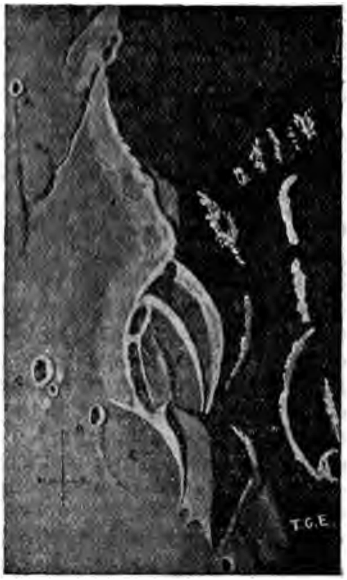
[*] "Zur Bestimmung der Rotationszeit der Sonne." Separatabdruck aus der 'Vierteljahrsschrift der naturforschenden Gesellschaft in Zürich,' xli. 1896.

[†] Since this paper was read, the August number of this Journal has arrived, in which (p. 105) Wilczynski draws the same inference—"*that the spots are at a higher level than the photosphere*"—from Stratonoff's results.

It will be seen from the drawing that the complex arrangement of rings composing Damoiseau is interrupted in a very remarkable and suggestive way on the north and north-west. The large outer and the smaller inner excentric ring are cut across by a wide plateau, which seems to represent a portion of the eastern *glacis* or slope of the incomplete formation E. The brilliant eastern rampart of this object, which has a bright little crater D at its southern end, form a conspicuous inflection in the coast-line. Under a low Suns it is obvious that it must be ranked with those partially destroyed rings so frequently met with on the borders of the lunar seas, for the relics of the western side of it are then easily traceable. There are two or three much smaller inflections immediately north of E, which seem to be the remains of ancient craters or depressions.



The most easterly of the details shown in the sketch pertain to the loftiest portions of the western boundary of Grimaldi; and the isolated illuminated objects between these and Damoiseau to another, unnamed, ring-plain, with large depressions on its wall, which abuts on the south-eastern flank of the latter.

The large crater shown by Schmidt at the extreme southern end of Damoiseau is traceable in the sketch, but its true character is not evident till a later stage. The inner ring includes some detail—a low ridge, and a dusky marking running from it to the eastern wall. Schmidt draws two rings (the more northerly being about twice the diameter of the other) on the western wall. It seems to me, however, that these objects lie between the outer rampart and the inner excentric formation.

Beaumont House, Shakespeare Road,
Bedford, 1896, October 19.

T. GWYN ELGER.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Galileo's Observations of Saturn.

GENTLEMEN,—

It is stated in several books on Astronomy (the statement would seem in some to be derived from that in Arago's 'Astronomie Populaire') that Galileo, after his perplexity caused by the appearance of Saturn in 1612, made no more observations of that planet. In an article in 'Popular Astronomy' for last April we are told that "Proctor, Flammarion, Young, and others are a unit in saying that Galileo's great perplexity (!) led him to abandon all further observations." Prof. Young wrote to the August number of the same periodical:—"I do not think I ever made such a statement, for I have long known better; and I certainly have not asserted anything of the kind in either of my three astronomical text-books."

My object in writing to you now is to point out that the statement is equally wrong respecting Proctor. In his 'Old and New Astronomy' (p. 616) he says:—"Though we may well reject the story that in his disgust at the strange phenomena he had witnessed, he determined to observe the planet no more (for such a feeling would have been utterly unworthy of him), yet he failed to interpret Saturn's changes of aspect." From a much earlier work ('Saturn and its System') it is evident that Proctor was acquainted with Galileo's later perception (in 1616) referred to in the April number of 'Popular Astronomy.' He there writes (p. 47):—"The changes that Galileo afterwards detected in Saturn's appearance were still more perplexing. The minor orbs reappeared, and waxed larger and larger, varying strangely in form; finally they lost their globular appearance altogether, and seemed each to have two mighty arms stretched towards and encompassing the planet. From a drawing in one of his manuscripts it has been supposed that Galileo suspected the true cause of these startling changes. In this drawing Saturn is represented as a globe resting upon a ring. It seems more probable, however, that this drawing is a modern addition to the manuscript, and that Galileo was never able to explain the phenomena whose succession he had observed and recorded."

The drawing is engraved on p. 35 of the fifth volume (which appeared at Florence in 1845) of a well-known edition of Galileo's works. Perhaps those who have access to the manuscripts will be able to clear up the point about the drawing and Proctor's suggestion; and perhaps something may appear on it in the National Edition now in course of publication. But it is evident that Proctor was well acquainted with not one of those who fell into the error of supposing that Galileo was so destitute of the scientific spirit as to abandon observations on an object the appearance of which had perplexed him.

Yours faithfully,

Blackheath, 1896, Sept. 23. W. T. LYNN.

'*Astronomia Anglicana.*'

GENTLEMEN,—

Having been recently offered (for a consideration) a copy of Greenwood's 'Astronomia Anglicana' (published 1689), I was led to examine that work* a little, with a result similar to that expressed by Delambre in the words: "L'œuvre.... est donc encore une de celles dont l'Astronomie n'a tiré aucun avantage, et qu'on peut aujourd'hui, sans le moindre scrupule, oublier entièrement" ('Histoire de l'Astronomie moderne,' vol. ii. p. 548).

Nothing whatever appears to be known of the author, except that, as he refers to some observations made by him at Chesham, in Buckinghamshire, we may presume that he resided there. The only matters of any interest in his book are the notices (p. 231) of what purport to be occultations of the south eye of the Bull (*i. e.* Aldebaran) by the northern horn of the Moon on February 5th, 1663, and of the northernmost star of the Pleiades by the southern horn of the Moon on February 3rd, 1674. If the stars in question were actually momentarily hidden by the Moon, as Greenwood's words ought to mean, these perceptions were rather remarkable and may be of some interest as lunar observations.

The author promised a continuation of his "painful" labours if he received encouragement, which it would seem he did not. Delambre naturally ridicules his pretensions to a knowledge of Greek, which must have consisted only in a knowledge of the letters, for he has tried to manufacture Greek words out of Latin, by a process of his own, *e.g.* ΔΟΚΤΡΙΝΑ ΣΦΑΙΡΙΚΑ, and still worse ΣΦΑΙΡΑ ΜΑΤΗΡΙΑΛΙΣ! I think I remember doing something of this kind when under ten years of age; but one would scarcely expect it from "an ancient sage philosopher, who *had* read Alexander Ross over,"—at least our author refers to his writings as having read them, which Samuel Butler probably had not. We may perhaps allow Greenwood some credit for rejecting the absurdities of judicial astrology, but surely not much. Morin was the last astronomer who professed any faith in these; and we cannot help thinking in this connection of the words of Horace affixed by Flamsteed to the horoscope which he had cast on the foundation of the Royal Observatory: "Risum teneatis, amici?"

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* The late Mr. Drach presented a copy to the R. A. S.

Yours faithfully,

Blackheath, 1896, Oct. 2. W. T. LYNN.

Frequency of Auroræ.

GENTLEMEN,—

The quiescence of the aurora at the last sun-spot maximum compared with some previous ones is worthy of note; in fact, the abundance of these phenomena that presented themselves at the 1870 sun-spot maximum is best indicated by an enumeration taken from a note-book.

The following refer to displays presented on a scale of some brightness only.

The fine auroræ of October 1847 and March 1861 were repeated at the following maximum.

In 1868 I recorded bright displays on Feb. 19 and Oct. 19. In 1869 on March 2, April 15, May 13, Sept. 27, Oct. 6. In 1870 on Jan. 8; Feb. 12, 23; April 21, 28; Sept. 24; Oct. 24, 25; Nov. 19. In 1871 on Nov. 9. In 1872 on Feb. 4. Of these, the one of May 13, 1869, gave the sky the appearance of an enormous umbrella, well-defined columns shooting up from all points of the compass to the zenith. Those of Oct. 24, 1870, and Feb. 4, 1872, were complete Arctic displays.

At the next period we have bright auroræ on 1880, Aug. 12, Nov. 3. In 1881 on Jan. 31. In 1882 on May 14, Oct. 2, Nov. 17. In 1883 on April 24. Total 7. At the late maximum they were noted on 1891, Jan. 11. In 1892 on April 25 and Aug. 12. In 1893 none. In 1894 on Feb. 28, March 30, June 3. In 1895 on Jan. 20, Nov. 9. In other words, 8 poor displays, not one of them, probably, equal to any of the 18 displays recorded in my note-book at the 1870 period, while at the next return the only remarkable display was that of Nov. 17, 1882.

On April 25, 1892, the sky was perfectly clear during the phenomenon, a very unusual circumstance. The rarest form of aurora, that of two succeeding arches on the horizon, I have never noticed.

Faithfully yours,

Melplash Vicarage, Bridport, S. J. JOHNSON.
1896, Oct. 6.

Curiosities in 20th Century Eclipses.

GENTLEMEN,—

On scanning the list of eclipses of each century there are always a few noteworthy points. If we take those of the next century, we notice seven eclipses in 1917 and 1935. In 1908 three solar ones, and no lunar, except a penumbral one. But the most remarkable occurrence is that in the nine years from 1985 to 1993 (both inclusive) no partial eclipse of the Moon and no eclipse of the Sun is visible in our land, but seven total ones of the Moon are visible here, partly or throughout. This is, probably, a unique instance.

It is this singularity in the incidence of eclipses that, by gratifying curiosity, makes it worth while to go through the labour of examining them at a great distance of time past and future, a matter which otherwise could possess little interest.

Faithfully yours,
S. J. Johnson.

Melplash Vicarage, Bridport,
1896, Oct. 6.

P.S.—In 1898 we shall have what has only happened once before during this century, viz. in 1833, three lunar eclipses visible at Greenwich. There was also a large solar eclipse that year, making four visible altogether: the latter was total across Iceland, including Mount Hecla; but this happened before the days of careful observation of such phenomena.

Observations of a Dark Spot in Jupiter's N. Hemisphere.

Gentlemen,—

With reference to Mr. Denning's paper in the September number of 'The Observatory,' on the spots in Jupiter's N. hemisphere, it may be of interest for me to mention that, on 1895 Jan. 26, while observing that planet with a 12½-inch reflector, power 200, I watched a fairly-conspicuous, medium-sized, dark spot, on the N. edge of the N. equatorial belt, transit the central meridian at $8^h\ 17^m$ G.M.T. (long.=233°), evidently the spot which Mr. Denning records as transiting at $8^h\ 18^m$ on the same date, and which he identifies with the "violin" spot, so frequently observed during the last opposition.

The chief interest attaching to my observation centres in the fact that this spot was *distinctly double*, being composed of two small, equal spots, which were partly merged into one another.

The line joining their two centres was approximately parallel to the direction of the belts.

Now I think that this observation goes a great way towards confirming the truth of Mr. Denning's surmise as to the identity of this spot with the "violin" spot, as there is a sufficient similarity in shape, due allowance being made for the effect of probable changes in the interval.

Up to the present this appears to be the first recorded observation of the "violin" spot *as such*, and as possessing any marked characteristic in shape.

At this date it was on the N. edge of the N. equatorial belt, while during the last apparition it has been perfectly isolated in the bright zone N. of the belt; but this fact can be explained as due to the great shrinkage in width undergone by the belt in question, and accompanying encroachment upon it of the bright zone to the N., the spot being left isolated like an island.

I observed on the same occasion another smaller spot, similarly situated, and also double, preceding the former by about 11° of longitude, but its duplicity was not so apparent as was that of the other spot. Subsequently, I made a drawing of the planet, with copies of which I should be pleased to furnish Messrs. Denning and Antoniadi should they desire it.

Yours faithfully,
H. Y. Childs.

Fortune's Well, Portland,
1896, October 12.

PUBLICATIONS.

Dunsink Observations: Part VII.—A volume of results of observations made at the Observatory of Trinity College, Dublin, has recently appeared, the first published under the direction of Dr. Rambaut, the present Director. This is a small catalogue of 717 stars, compiled from 2127 observations of right ascension and 2137 of declination made with the Pistor and Martins meridian circle of the Observatory by Dr. Rambaut, Mr. Lyster, and Mr. C. Martin, who have been successively the Assistants at the Observatory since 1885.

The design of the work was to make it a catalogue for the determination of proper motion, and a working list was therefore made of stars from various catalogues whose proper motion on a great circle was given as greater than 0″·2. We need say but little of the details of the determinations of the instrumental constants and corrections, which are all given in the introduction to the catalogue. The clock errors were deduced from the star-places given in Auwers' 'Fundamental Catalogue,' and the latitude adopted was derived mainly from comparison of observed declinations of stars with their places as given in the same work. This present catalogue therefore depends entirely on that of Dr. Auwers.

Besides the catalogue itself, there is given a ledger showing the individual observations reduced to 1890·0. From these separate results probable errors of a single determination have been deduced, ±0″·037 in R.A., and ±0″·505 in Declination.

NOTES.

Comet Notes.—It appears that the comet announced last month as having been discovered by Mr. Brooks was really discovered by Mr. W. E. Sperra, of Randolph, Ohio, on Aug. 31. Having no telegraph office in the neighbourhood, he sent the announcement by rail to Allegheny Observatory, requesting the authorities to distribute it; this, however, they unwisely omitted to do, desiring to see the comet themselves before circulating the announcement. However, a gentleman from Allegheny Observatory mentioned the discovery verbally to Mr. Brooks on Sept. 4, who quickly succeeded in finding it. In telegraphing to Harvard he stated that the comet was probably Sperra's; but this was not transmitted in the telegram to Europe, hence the discovery at first was supposed to be due to Mr. Brooks.

The following improved elements are by Dr. Lamp:—

T = 1896 July 10·9814 Berlin M.T.

ω	41° 2′
☊	151 2
i	88 26
log q......	0·0579

Ephemeris for Berlin midnight.

	R.A. h m s	N. Dec. ° ′		R.A. h m s	N. Dec. ° ′
Nov. 3....	18 35 39	29 4	Nov. 11....	18 56 53	25 38
7....	18 46 34	27 17	15....	19 6 42	24 6

The comet is now extremely faint.

M. Perrotin has deduced the following elliptical elements for Comet Giacobini from observations made at Nice on Sept. 4, 12, and 27 (Comptes Rendus, No. 15).

Epoch 1896 Sept. 15·5 Paris M.T.

M	353° 33′ 28″	1896·0.
π	334 18 48	
☊	193 34 34	
i	11 20 32	
φ	35 50 19	
log a	0·544114.	
Period	6^{y}·549.	

Perihelion Passage	Oct. 28·31
Perihelion Distance....	1·451
Aphelion Distance .. .	5·549

The comet thus appears to form one of the Jovian family, and its elements somewhat resemble those of Faye's Comet.

The following ephemeris (for Paris midnight) has been computed from these elements:—

	R.A. h m s	S. Dec. ° ′		R.A. h m s	S. Dec. ° ′
Nov. 4....	19 56 3	13 47	Nov. 19....	20 46 19	13 10
9....	20 12 56	13 41	24....	21 3 12	12 43
14....	20 29 31	13 29	29....	21 19 47	12 12

The brightness is 0·8 of that at discovery on Nov. 4, and 0·6 on Nov. 29.

The following is a continuation of Bauschinger's ephemeris of Brooks' Comet (1889 V.); it is for Berlin midnight:—

	R.A. h	m	s	S. Dec. °	′
Nov. 4....	22	26	23	12	20
8....	22	30	39	11	36
12....	22	35	15	10	50
16....	22	40	11	10	2
Nov. 20....	22	45	25	9	13
24....	22	50	54	8	23
28....	22	56	39	7	32
Dec. 2....	23	2	36	6	40

Prof. Chandler points out (Ast. Journ. 385) that four components of this comet were visible in 1889, and that Mr. Charles Lane Poor's assumption that the comet now visible is identical with the component designated A is not absolutely certain. He requests astronomers to search for the other components. Component C should be about 3½′ distant from A.

Ast. Journ. 385 contains an account by Mr. Swift of the discovery of the daylight comet on Sept. 20. Happening to look at the setting Sun he saw a bright object about 1° above it. With an opera-glass he saw that it had a fainter companion some 30′ north. Both objects disappeared behind the horizon about 4 minutes later, but not till their existence had been verified by 15 people. All attempts to recover the objects next day were fruitless till the Sun had begun to set, when one of them was seen for a few seconds with the comet-seeker. Neither object has since been seen, and it is to be feared that they will now escape undetected.

'Bulletin Astronomique' for September contains definitive elements of Comet 1885 III. (Brooks) by Mdlle. Klumpke. This comet was discovered on Aug. 31, 1885, and 76 observations were obtained between that day and Sept. 16. Then followed 12 days without an observation; it was observed by M. Bigourdan on Sept. 28, Oct. 1, 4, and by Dr. Copeland on Oct. 5.

Prof. Campbell and M. Gallenmüller had already published elliptical elements with periods of 496 and 403 years respectively. They did not, however, know of M. Bigourdan's three observations referred to above, which Mdlle. Klumpke now makes use of.

She obtains the following elliptical elements:—

T = 1885 Aug. 10·163865 Paris M.T.

π	247° 36′ 58″	1885·0.
☊	204 45 25	
i	59 6 35	
$\log q$ ..	9·874568	
e	0·98226	
Period.	247·5 years.	

She considers that the error of the excentricity is not greater than 0·005, and that the period certainly lies between the limits 189 and 451 years.

The least distance of the orbit from that of Jupiter is only 0·22, so that the comet has probably been captured by Jupiter.

The following is a search ephemeris of Spitaler's periodic Comet (1890 VII.), which will pass its perihelion in March 1897:—

	R.A.			S. Dec.			R.A.			S. Dec.	
	h	m	s	°	′		h	m	s	°	′
Nov. 4	22	58	0	19	48	Nov. 16	23	2	42	17	17
8	22	59	4	19	1	20	23	5	10	15	22
12	23	0	39	18	10	24	23	8	1	15	25

The brightness is about 0·27 of that at discovery in 1890.

Dr. Anton Schobloch has determined the following elements of Comet 1870 II., which was discovered by Coggia, 1870, August 28, and was under observation up to December 23 (Ast. Nach. 3383). The number of observations available is 311.

$$T = 1870 \text{ Sept. } 2{\cdot}23182 \text{ Berlin M.T.}$$

$$\left.\begin{array}{lr} \pi \ldots\ldots\ldots & 7^\circ\ 53'\ 15'' \\ \text{☊} \ldots\ldots\ldots & 12\ \ 56\ \ 19 \\ i \ldots\ldots\ldots & 99\ \ 21\ \ \ 4 \end{array}\right\} 1870{\cdot}0.$$

$$\log q \ldots\ldots\ 0{\cdot}259277$$

There is no evidence of any deviation from a parabola.

A. C. D. C.

Minor Planet Notes.—A new planet DA was discovered by Herr Witt, of the Urania Observatory, Berlin, on Oct. 8.

Planet 324, discovered by Palisa 1892, Feb. 25, has been named Bamberga.

A. C. D. C.

Obituary.—We have been informed of the very sudden death of M. F. Tisserand, Director of the Paris Observatory, which happened on October 20. We hope to give in our next number an adequate account of the life and works of this distinguished astronomer, whose loss we much deplore.

We regret to hear of the death of Mr. George Hunt, who died on July 9th last. At the Astronomical Society and other similar meetings, where he was a constant attendant, his familiar figure will be much missed. Mr. Hunt was born at Liverpool in 1823, and from youth took a great interest in optical instruments. He first devoted himself to microscopical science, but later studied astronomy with great delight. He was elected a Fellow of the Royal Astronomical Society in 1866, and in 1869 became the possessor of the late Rev. W. R. Dawes's equatorial, which he established at his Observatory at Dulwich. A retiring disposition prevented his taking a prominent public part in the astronomical world, but his knowledge of the subjects he studied was very thorough, and those who knew him intimately were surprised at the extent of his general knowledge. He was a Fellow of the Microscopical Society as well as of the Astronomical, and occasionally contributed to this magazine and other publications.

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In the 'Washington Post' of Sept. 22 we read of the death of Prof. W. C. Winlock, assistant at the Smithsonian Institution. The following facts relating to the deceased gentleman are extracted from that journal:—

Prof. Winlock was born in Cambridge, Mass., on 1859, March 27. His father, Joseph Winlock, was Professor of Astronomy in Harvard University and Director of that Observatory. After graduating at Harvard in 1880, the younger Winlock was appointed to a post at the Naval Observatory, Washington, which he held until 1889, when a vacancy occurring in the Smithsonian Institution, he was chosen by the Secretary, Prof. Langley, to fill the position of Curator of International Exchanges. Here his duties being administrative, his astronomical work was chiefly of a literary nature; his series of reports on the "Progress of Astronomy" are no doubt familiar to many. He also delivered lectures on Astronomy in the Columbian University in Washington. Prof. Winlock visited Europe this last summer, in company with Prof. Langley, on the business of the Institution, but having previously been in a weak state of health, owing partly to close attention to work, the fatigue of the trip prostrated him, and he died after a short illness on Sept. 21 last.

We hear, too, of the death of Mr. E. P. Sells, second Assistant at the Adelaide Observatory. Mr. Sells, the son of the Rev. Alfred Sells, was born in England in 1861, but went to South Australia at an early age, and entered the Survey Department of the Colony in 1879. He remained in this service until 1882, when he was appointed assistant to Sir Charles Todd at the Adelaide Observatory. Here, despite much ill-health, which compelled him to twice return to England on sick-leave, he proved himself an exceptionally good computer and an efficient assistant. A paper on Jupiter written by him, with a beautifully executed series of drawings, was communicated by Sir C. Todd to the Royal Astronomical Society quite recently, and will no doubt be shortly published.

In 'Popular Astronomy' for October, Prof. S. W. Burnham has a paper entitled "The Binary Systems," in which he gives some interesting information and also some much needed plain words to computers of double-star orbits. Prof. Burnham summarizes an enormous mass of material which he has collected in the following list, giving the number of stars catalogued as double, within 120° of the north pole, arranged in groups in order of Right Ascension:—

Between Right Ascension	0^h– 3^h ……	1750
	4 – 7 ……	2020
	8 – 11 ……	1760
	12 – 15 ……	1250
	16 – 19 ……	1850
	20 – 23 ……	2310
	Total ….	10940

The measures of these stars have been examined and all worthy of attention (in general this means where the distance is under 2″) have been classified as below:—

I.	Orbits, good	36
II.	Orbits, worthless or very doubtful	42
III.	Binary	59
IV.	Probably Binary	134
V.	Class 1 (0″ to 1″)	696
VI.	Class 2 (1″ to 2″)	805
VII.	Common proper motion	115
VIII.	Type of 61 Cygni	45
IX.	Rectilinear motion	290

"Thus more than half of the 78 orbits which have been computed down to this time are not only wholly unreliable, but in many instances it is not certain, even now, that the stars are binary at all. There was no excuse for most of these computations. Almost any kind of curve, and even a straight line, will equally well represent the observations." Prof. Burnham emphasizes this straightforward language by showing the plotted observations of Σ 1757, OΣ 82, and γ Leonis. Nothing better represents the observations of Σ 1757 than a straight line, "and yet four orbits have been computed for this pair! To be sure, they differ by more than one hundred years, although each period is given to within a few days." Similarly three orbits have been computed for γ Leonis, the observations of which are equally well represented by a straight line. Two orbits have been computed for OΣ 82, which, "if binary at all, the years of revolution are as likely to be in the thousands as in the hundreds."

These remarks are not intended to damp the ardour of computers, but rather to point out the precarious nature of the material and the difficulty in handling it, and that we must leave to future generations the solution of stellar motions. The best means now of assisting to unravel these motions is to make careful observations, the time spent on which is not thrown away, although they may not in the lifetime of the observer definitely settle the questions at issue.

THE FLEXURE OF THE CIRCLE OF A MERIDIAN INSTRUMENT.—The details of a determination of the flexure and division errors of a circle can scarcely be considered a subject of general interest, but a long memoir by Prof. Lewis Boss in Nos. 382 and 383 of the 'Astronomical Journal,' which describes an investigation of this kind, the subject being the instrument in use at the Albany Observatory, will be read with interest and profit by those who have similar instruments under their care. One result found in the course of the work, which is rather surprising, may be described in general terms as follows:—The angle through which a perfectly rigid and perfectly centered circle is rotated would be shown by the difference of the readings of the microscopes before and after the rotation, but with an actual circle this will not be exactly the case, because, first, the circle may not be divided quite uniformly, which gives rise to division-correction; and, secondly, because the circle may take up a different form in the second position, owing to "the resultant effect of an infinite number of loads unsymmetrically distributed upon the circle, such as might arise from slight variation in the form or density of various sections of the circle." Prof. Boss made some experiments to determine the amount of the correction due to this latter cause. The circles of the Albany instrument, which are each carried by ten radial spokes 380 mm. in length, of trapezoidal cross section, tapering from a greatest thickness of 33 mm. to 19 mm. (the material is not stated), was clamped firmly, and the microscopes having been read, a weight of 8 ounces was suspended from the south horizontal point of the circle, and this caused the mean reading of the microscopes (there are four of them) to increase by about 6″. The weight being then removed to the point 180° from its first position, the microscopes gave a reading almost 6″ less than the first. It must be noted that the direction of these changes implies a movement of the circle towards the weight, and also that a comparison of the readings of the four microscopes seems to show that there was no sensible distortion of the circle. This seems a large quantity to be applied as corrections, if such effects are likely to arise in the normal use of the instrument; but Prof. Boss points out, first, that though it looks large in angular measure, in actual length on the circle it represents a very small quantity; that the amount of the flexure is of no moment if it follow the theoretical law, represented by $F \sin (R+\alpha)$, where F and α are constants and R the circle-reading; but that the important point is to determine division-errors, which will include flexure, accurately at all points of the circle, and to this end he thinks that it would be a great advantage to increase the size of the circles, as the divisions of a large circle are likely to be more exactly laid down, and also any errors they may have may be determined with more facility.

THE ADJUSTMENTS OF AN EQUATORIAL TELESCOPE.—Much has been written at various times about methods of adjusting an equatorial, but the last word has not been said yet on this subject, which has lately been approached from, we believe, a novel point of view in the course of the work on the Astrographic Chart at Greenwich. It will at once be seen by anyone accustomed to an equatorially mounted telescope that if the instrument be not properly adjusted and the horizontal wire in the eyepiece be set to coincide with the direction of motion of a star as seen with the instrument in any particular position, pointing to the equator say, and that if the instrument be turned to any other position, the wire will not so coincide, owing to the mal-adjustment. In fact, if the four errors of collimation, perpendicularity of declination axis to polar axis, altitude of pole, and displacement of pole perpendicular to the meridian be represented respectively by, c, i, a, and p, the inclination of the path of a star of declination δ will be affected by an error

$$= (c \tan \delta + i \sec \delta + a \cos h \sec \delta + p \sin h \sec \delta),$$

h being the hour-angle. We leave the proper signs of each term for particular cases to be supplied by the reader, remarking only that c and i change sign as the telescope is east or west of the pier. It will be now seen that by taking photographic trails of stars at suitably chosen points of the sky, and measuring their inclination to the horizontal réseau line, that it is possible to find a series of equations well adapted for determining any or all of these errors. Though this method seems especially suitable for a photographic telescope, it might be adapted to an ordinary equatorial.

RESUMING his researches on the motion of the Sun in space, Dr. O. Stumpe has made a much more elaborate investigation of this subject than his previous work. He selects 1000 stars and separates them into three groups according to each of these three classifications:—(*a*) according to proper motion, (*b*) according to magnitude, (*c*) according to parallax.

Then for each group in these arrangements he derives the following values:—

	Group.	Mean P.M.	Mean Mag.	No. of Stars.	Sun's Apex. R.A.	Sun's Apex. Dec.
		″	m			
a	1	0·23	6·34	551	284·4	+41·5
	2	0·43	6·70	339	285·7	+41·9
	3	0·85	6·38	106	287·7	+33·1
b	1	0·39	8·18	284	286·7	+46·9
	2	0·36	6·63	473	290·7	+37·5
	3	0·36	4·12	238	263·8	+31·1
				Mean Par.		
c	1	0·23	7·12	0·032	287·4	+45·0
	2	0·39	6·82	0·048	282·2	+43·5
	3	0·55	4·89	0·087	280·0	+33·5

His investigations do not end here, for he further subdivides each class and finds that the decrease in declination shown above is brought out even more prominently.

A SPECTROSCOPIC BINARY, μ_1 SCORPII.—The most recent Harvard College Circular states that an examination of 35 photographs of the spectrum of this star show that it is a binary star, whose components revolve round one another in a nearly circular orbit in a period of 35 hours. This star is one of a pair, μ_1 and μ_2 Scorpii, which are so close that the spectra of both stars appear on the same plate, and the difference in the character of the lines is well marked. Those of μ_1 are sometimes broad and hazy, at other times they appear double, whilst those of μ_2 always appear sharp and well defined, pointing therefore to the conclusion that the difference in the appearance of the lines of μ_1 indicates a real physical fact.

ON THE PRESENCE OF OXYGEN IN THE SUN.—Mr. T. Trowbridge, in the 'American Journal of Science,' pp. 329–333, 1896, gives an account of his recent work on the spectra of carbon and oxygen. After giving a *résumé* of his researches in 1887, he describes his observation of the appearance of the carbon spectrum when iron is introduced as an impurity. He made comparisons of the spectra of pure carbon and of carbon dust having varying proportions of iron uniformly distributed through them. The portion of the spectrum photographed was in the ultra-violet region about 3883·7, where traces of the band-spectrum of carbon have long been suspected in the Sun. Mr. Trowbridge found that when the proportion of iron to carbon was from 28 or 30 per cent. to 72 or 70 per cent. respectively, the iron was capable of completely masking the peculiar banded spectrum of carbon. Experiments on the mutual action of iron and oxygen showed that the faint lines of iron were not masked by the nebulous oxygen-lines. He concludes by expressing the opinion that, although oxygen has not yet been definitely detected in the Sun, "the fact of there being a combustion of carbon and other bodies seems to indicate that the Sun's light is due to carbon vapour in an atmosphere of oxygen."

SOLAR RADIATION.—A new determination of the Solar Constant, or "the number of calories received normally in a minute on a surface 1 cm. square at the upper limit of the atmosphere," has been made by M. Vallot (Proc. of Phys. Soc. 1896, Sept.). The method adopted was that of M. Violle, in which simultaneous observations are made at different altitudes, to afford a means of determining the value of atmospheric absorption. The two stations selected were Mont Blanc (4807 m.) and Chamounix (1040 m.), and a mean station, Grands-Mulets (3020 m.). In the result M. Vallot considers that the solar constant cannot amount to 2 calories. His mean value is 1·75 calories.

THE BRITISH ASTRONOMICAL ASSOCIATION. — The Officers, Council, and Members of the Eclipse Expedition of this Association met at dinner on October 27, in the Caledonian Saloon of the Holborn Restaurant, the President, Mr. E. Walter Maunder, occupying the chair. Ninety-two guests were present, and the proceedings throughout were of the most enjoyable character. After the usual loyal toasts Lord Hampton proposed the President Elect, Mr. Green, and the British Astronomical Association, to which Mr. Green replied. Sir R. S. Ball proposed Dr. Downing and the Members of the Eclipse Expedition, and in a most amusing speech dwelt on the pleasures of the cruise, concluding with a humorous censure of the 'Daily Graphic' artist. Dr. Downing in acknowledging remarked that the expedition had not been devoid of scientific interest; in particular he had been struck with the operation of the laws of "natural selection," by which all the best observers monopolized all the most charming young ladies. Mr. Crommelin proposed the Astronomer Royal, and the Friends and Helpers of the Eclipse Expedition, to which the Astronomer Royal replied. Mr. Lunt proposed Dr. and Mrs. Sidebotham and the Branches of the Association, to which Dr. Sidebotham, of the Manchester Branch, replied. Mr. Sidney Waters proposed the Ladies, and Miss Gertrude Bacon replying, claimed the right of ladies to answer for themselves instead of having some stammering youth put up to reply for them. She also warmly thanked the Association for having admitted women as members and officers on a perfect equality with men. Mr. Cottam proposed the President, who, in acknowledging the toast, said the spirit actuating the Association was that of "Help and Work," and that that spirit had caused its remarkable growth and would secure its continued prosperity.

British Astronomical Association.—The following ladies and gentlemen have been chosen to serve as Officers for the ensuing Session:—*President*, N. E. Green; *Vice-Presidents*, A. M. W. Downing, Mrs. A. S. D. R. Maunder, Capt. William Noble, The Right Hon. The Earl of Rosse; *Treasurer*, W. H. Maw; *Editor*, E. Walter Maunder; *Secretaries*, James G. Petrie, William Schooling; *Librarian*, F. W. Levander; *Directors of the Observing Sections*: *Sun*, Miss Brown; *Moon*, T. G. Elger; *Mercury and Venus*, Henry MacEwen; *Mars*, E. M. Antoniadi; *Jupiter*, Rev. W. R. Waugh; *Saturn*, N. E. Green; *Comets*, W. E. Plummer: *Meteors*, H. Corder; *Star Colours*, G. F. Chambers; *Variable Stars*, J. E. Gore; *Double Stars*, G. M. Seabroke; *Spectroscopy*, J. Evershed, junr. *Other Members of the Council*, Miss A. M. Clerke, Rev. A. L. Cortie (S.J.), Arthur Cottam, A. C. D. Crommelin, J. D. Hardy, G. T. Davis, Arthur Kennedy, Thomas Lewis, Joseph Lunt, G. J. Newbegin, H. Seward, Rev. W. Sidgreaves (S.J.), David Smart, F. J. Wardale.

The following messages from the Lowell Observatory appeared in a recent number of the Ast. Nach.:—"Oct. 4. Phison and Euphrates, Martian canals, are double." "Oct. 5. Mercury and Venus rotate once on their axes in a revolution around the Sun. Venus is not cloud-covered, but veiled in an atmosphere, Mercury is not." Possibly the compression necessary for a cablegram is responsible for the definiteness of these statements, which at first sight look rather too final.

It is announced that a new Observatory is to be established at Rössgen Mittwerde, Saxony. Dr. Friedrich Krueger is to be the Director, and his proposed programme includes (1) the formation of a photometric catalogue of coloured stars; (2) photometric determinations of comparison stars used in the observation of variables; and (3) construction of star-charts by photography of regions containing variables.

FROM AN OXFORD NOTE-BOOK.

WE left Yokohama on August 21 in the 'Empress of China.' The most picturesque incident of our return voyage across the Pacific was the appearance on board of the Korean Minister to the United States, with his wife and boy, all dressed in native costume. They remained in seclusion until we got under way, for fear of accidents from misguided Japanese; but came on deck as soon as we were so far at sea that the captain could deal appropriately with evildoers on his own responsibility. If you are to be assassinated, it is more satisfactory to feel that the other fellow will not get off scot-free. The Korean boy was a merry little chap, with two twisted horns of hair, which he declared should be cut off when he got to America. The voyage was very peaceful and the boat as comfortable as it could be made, the motto of the steward being that anyone might have a meal at any time: yet we were unfeignedly glad to see Vancouver. After a short rest there we went on to Glacier, a beautiful little oasis in the Rocky Mountains, and took some of the creases out of our muscles by a little hill-climbing. Thence we made for Chicago and the Yerkes Observatory.

THE Custom-house warned us that we were leaving Canada for the States; but I think we might have inferred this fact independently from little incidents of travel. The jolting of the cars sensibly diminished, owing to the more careful laying of the track; signs of cultivation were more numerous as we approached the older civilization; the meals went up 5 per cent. in quality and 30 per cent. in price; the gentleman of colour who manipulated our sleeping arrangements sat down in the smoking-room and asked us a few friendly questions about Japan; and we began to hear of "free silver" and "honest money." Even such a small matter as the substitution of the legend "Keep Out" for the more familiar "Private" on the office doors seemed significant. The customs' examination was conducted at midnight in a shed lighted by one candle: the apology offered for these rather primitive arrangements being that "the country was not settled up yet."

ON Friday, September 11, at 9.31 A.M., we struck Chicago. Professor Hale met us with a hearty welcome and our mail, and proposed an immediate visit to the Yerkes Observatory. While we were catching our breath he checked our baggage to the Auditorium Hotel, settled us in an omnibus, and drove off to the other depot. At 9.55 we were on the special train which was to convey the University Trustees and our unworthy selves to Lake Geneva; and interviewers were explaining to us what we were expected to say, and drawing pictures of us. At 9.59 Assistant-chief-train-despatcher Williams signalled Engineer Walker to pull out; the evening-paper news-gatherers prepared to descend, and we got under way. As the last reporter clung with one hand and one foot to the already moving train he remarked that "very often the quintessence of experienced opinion can be summed up in a single sentence. Can you give me that sentence?" I mournfully shook my head, and he dropped with a courteous wave of the hand. Portraits of the criminals and their confessions were in the evening and morning papers; and it seems that the writer of these notes "bore a distinguished appearance." This method of referring to an increase of personal avoirdupois seems to me particularly graceful and delicate.

THE train journey durated about two hours, and we were regaled with lunch on board. Then we had a short steamer trip on Lake Geneva, a short walk, and we were at the Observatory. I was figuring on Chicago being remarkable for having three observatories at the present time—Dearborn, Kenwood, and Yerkes; but it was suggested that on the same terms London might claim Greenwich, Oxford, and Cambridge, not to speak of Tulse Hill, South Kensington, Ealing, and others. Distances are large on this side of the Atlantic, and the Yerkes Observatory is really 80 miles from Chicago, though it is considered as a department of the Chicago University. However, there is nothing remarkably novel in this arrangement when we remember that Harvard has an observatory in Peru. It may be remarked here that the postal address is "Yerkes Observatory, *Williams Bay*, Wisconsin," *not* Lake Geneva, which takes the letters to a town of that name some distance away. The lake itself is, however, a charming feature of the immediate vicinity of the Observatory, and Professor Barnard is building himself a house, one window of which commands a fine view of the Observatory, and another an equally fine view of the lake.

PROFESSOR BARNARD met us as the steamer came to land, and we were very glad to find him recovered from his recent illness—looking, in fact, quite strong and hearty. Ten minutes up the hill to the Observatory. The building is well advanced but not yet completed, and the opening ceremony has now been put off till next summer, so that those who visit Toronto with the British Association may perhaps have a chance to be there. The framework of the big dome (95 feet in diameter) is up, and also the huge iron pier for the telescope, and the stonework of the building generally is complete. There is no doubt about the magnificence of the structure, whether seen from a distance or close at hand. Mr. Yerkes's generosity has been on a scale which rendered economy needless, and hence not only are there plenty of rooms and laboratories, and plenty of room in each, but, architecturally and artistically, the building is in the first rank. A noticeable point in the architecture of the dome is its truncated form—a hemisphere surmounting a short cylinder—which obviates the squat appearance characteristic of most hemispherical domes, and which, it may be remarked, was adopted in the Oxford University Observatory in 1874.

It is too early to say anything of the equipment of the Observatory. That there is to be a 40-inch telescope (61 feet focus) is sufficiently well known; but though the instrument was mounted at the World's Fair in 1893, its component parts are at present rather scattered. The spectroscope for it we saw and admired at the Kenwood Observatory, where it has been mounted for trial. The Kenwood 12-inch is to be transferred to the Yerkes Observatory, and there is also to be an 18-inch. Very complete arrangements have been made for heliostatic work, for making and using gratings, and so on. But there will be more to say of such things in a year or two. At present Professor Hale is at work, when he has leisure from the superintendence of the building, with a bolometer, hoping to get some evidence of the corona. We pointed out to him that it seems essential to come with us to the Eclipse of January 1898 if he would thoroughly test this method, and he has acknowledged the force of the remark. Miss Hale will then be seventeen months old.

Professor Barnard has used the present period of expectancy to do two excellent things: firstly, to get a thorough rest and restore himself to health, and, secondly, to determine the best means of reproducing his photographs. A public subscription in San Francisco has given him the wherewithal, and the reproductions will be published as a volume of the Lick Observatory publications. Under his direction a great many experiments on photogravure processes have been made, and the process finally selected gives beautiful results, of which he kindly allowed us to carry off a few samples. Professor Burnham was, to our great regret, away, and we did not see him; he is to work the great telescope on Saturday and Sunday nights, but will be in Chicago all the week. But if we did not see him we heard much of him from Professor Barnard, whose face glows with animation as he speaks of the untiring energy and marvellous skill of his friend. The only other member of the staff at present appointed is Professor Wadsworth, who will take the physical department—bolometric, gravitational, &c. The scientific ability of all these gentlemen is demonstrated by their published works: it is only by a visit to Chicago that one discovers their equal ability in making life pleasant to their guests.

A visit to Professor G. W. Hough at the Dearborn Observatory (attached to another Chicagoan University, the "North-Western") showed us how necessary it is to see an astronomer at home if you would really learn what he is doing and what manner of man he is. Professor Hough is surrounded with mechanical contrivances of the greatest beauty and ingenuity, made by himself, which must be seen to be appreciated. His printing chronograph, for instance, which prints the minutes, seconds, tenths, and hundredths of any chronographic signal, is a thing of joy; and there is a ecording barometer, an observing-chair, and a motor for moving the big dome, all of which one would like to steal. It is possible that the art of the constructor has concealed the real complexity or delicacy of some of these pieces of apparatus: they might not work so well in hands less skilful than his own; but it is hard to believe this when one sees them; and I for one mean to have a Hough observing-chair made as soon as I get home. It is described, I gather, in the 'Monthly Notices' (about 1880 or 1881). The chief instrument of the Observatory is the 18-inch Alvan Clark, with which the companion to Sirius was discovered, and with which Professor Hough has done so much work on double stars. He delights in this instrument and is fond of telling Mr. Clark that it is the finest object-glass ever made by the firm; but I hope the mention of this will not bring a libel action down on the Editor of this Magazine.

American Universities are very different from European, and the consideration of a few elementary facts is almost sufficient to show the danger of reasoning by analogy from one to the other. The University of Chicago, for instance, is but four years old, instead of several centuries. Five years ago not a stone of the foundations was laid, and now it is a vigorous concern with acres of fine buildings, thousands of students, publishing ten journals (of which the 'Astrophysical Journal' is one), and spending some £100,000 annually. The North-Western University is but little older; it has as many undergraduates as Oxford, and many more professors (130), but is partly technical in character. For instance, one of its eight faculties is a Dental School, with sixteen professors, including a Professor of Dental Jurisprudence, whatever that may be. And there are other Universities in Chicago which we had no time to visit. One went bankrupt some years ago and was demolished. Such facts show how misleading comparisons with Old World Universities may be. One common characteristic of the Chicago Universities may be illustrated by an extract from the Statutes of the North-Western University, dating from 1855, viz.:—"SECTION II.—No spirituous, vinous, or fermented liquors shall be sold, under license or otherwise, within four miles of the location of said University, except for medicinal, mechanical, and sacramental purposes, under penalty of twenty-five dollars for each offence, to be recovered before any Justice of the Peace of said County of Cook." Fancy trying to run (say) a Scotch or German University on these lines!

THE Junior Member of the Expedition has been rather sleepy the last day or two. He is only eleven, and a long train-journey with short nights, and the visits to observatories in which he feels only a secondary interest, have produced this natural result. He would like to be back again at Akkeshi, I expect, catching frogs in Professor Schaeberle's pond or collecting rin from the Japanese temples. Japanese coins are things to delight a boy's heart; they are very pretty and inexpensive. It takes one thousand rin to make up a dollar, value two shillings; and thus a very fair collection of coins can be got together without mortgaging pocket-money for years to come. I hope the phrase about collecting the rin from the temples will not be misunderstood; it is a strictly legal proceeding, and consists in asking the priest in charge whether he will kindly change a five sen piece into the small change scattered in offering by the pilgrims, which the priest generally does with a benignant smile, but at the same time a rather puzzled air. The Junior Member finds it a good game just now to sit quite still and solace his sleepy eyes with a good look at all his treasures, which are always in his pockets. He wants to know if we are as tired as he is; and, if not, why? When quite fit, he can ask more questions to the hour than a full-grown barrister, and is infinitely more amiable in receiving the replies, which I fear are sometimes not suitable for delivery in the witness-box. But the day's rest at Niagara has done him good, and he is picking up again rapidly.

As a matter of fact we are all rather tired and glad of the day at Niagara. I have planted myself on the balcony of Clifton House, in full view of the Falls, and contemplate them with the greatest satisfaction whenever the pen stops to rest, as pens will. From below there has just floated up to my ears the following conversation:—

AGENT: Like a carriage today, sir, to see all the sights?
VISITOR: No, thank you.
A.: Like to look at this bazaar just here, sir? Very nice curiosities and suvneers.
V.: No, thank you.
A.: I was only just telling you of them, sir; I'm not *interested* in them.
V.: Neither am I, thank you.

THE OBSERVATORY,

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MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, November 13, 1896.

Dr. A. A. Common, F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. Turner, M.A., B.Sc., and
E. W. Maunder.

The Minutes of the previous Meeting were read and confirmed.

Mr. Maunder. No fewer than 220 presents have been received since the date of the last Meeting. Among those calling for special notice is the tenth volume of the collected mathematical papers of Professor Arthur Cayley, also the Indian Calendar, by R. Sewell; a very important book with tables for the conversion of Hindoo and Mohammedan dates into those of modern chronology; the third volume of the Annals of the Royal Observatory, Cape of Good Hope; a map of India, showing the path of the shadow and limits of totality on the occasion of the Eclipse of the Sun on January 21, 1898, presented by the Indian Survey Department; a little book by Mr. Lynn on 'Remarkable Eclipses'; the sixth volume of Memoirs on the Transit of Venus 1882, presented by the German Transit of Venus Commission; the eleventh volume of the complete works of Laplace; the volume of the Catalogue of the Astronomische Gesellschaft, containing the zones $+15^\circ$ to $+20^\circ$; and a number of photographs. There is a large photographic atlas of the Moon from Messrs. Loewy and Puiseux; a number of photographs from the Lick Observatory, comprising fourteen original new negatives of Jupiter and Mars. Also a picture showing an enlargement of a sun-spot, presented by Dr. Max Wolf; and a series of photographs of the Milky Way Clusters from E. E. Barnard; and from Professor Crew photographic maps of Metallic Spectra.

The President. The Secretary has mentioned some of the principal presents calling for notice, and I will ask you to return your thanks to the donors, especially to the gentlemen named.

We have also received two boxes of negatives from the Lick Observatory, which contain photographs of Jupiter and of the Moon; and an enlarged picture of a sun-spot, taken in September, with, I believe, the whole aperture of the 36-inch telescope with correcting lens in front.

Professor Turner. One of the papers we have before us this evening has a melancholy interest. It was sent by Sir Charles Todd from Australia, in the hope that it would be in time for the June meeting, but did not arrive until June 23rd. The paper I refer to is by Mr. Sells, on Jupiter. The letter accompanying the paper said that for many years special attention had been paid at the Adelaide Observatory to the physical appearance of Jupiter, and on the appointment to the Observatory of Mr. Sells, who was an excellent draughtsman, the observations assumed a more systematic character, and it was hoped that drawings would be regularly published. In the meantime a short paper has been sent, giving Mr. Sells' observations and drawings, extending from 1884 to 1893. It is, perhaps, within the knowledge of Fellows that lately the sad news of Mr. Sells' death has arrived. The paper will be published in the 'Monthly Notices.'

Professor Turner. Mr. Percival Lowell's papers on Mercury and Venus are of extreme interest, whatever may be thought of the trustworthiness of the results.

Prof. Turner then read the paper on Mercury and Venus. The gist of Mr. Lowell's paper was this:—There are a number of different markings on Venus which were seen continuously in the same place for several days together; but sometimes, on the other hand, they were not seen for several days. His opinion is that these markings are never obscured by clouds on the planet; but when they were not seen, this is due to our own atmosphere, and he concluded from them that Venus rotated on her axis in the time of her sidereal period. Mr. Lowell also thought that Venus has an atmosphere, but free from cloud, and the markings are not of the same artificial character as he supposes those of Mars to be.

Captain Noble. This looks to me suspiciously like Mars. I do not know whether Mr. Lowell has been looking at Mars until he has got Mars on the brain, and by some transference has ascribed the markings to Venus.

The President. They are not inconsistent with probability; in fact the probabilities point to a similarity. Perhaps this paper comes rather as a surprise to the Meeting. I think it is a most valuable one. There is hardly one planet of the solar system which has received less productive attention than Venus. We have our previous notions very rudely shaken, not only as to the amount of atmosphere which Venus is supposed to have, but as to the period of rotation. If anyone has studied Venus I should like to hear his remarks on the paper.

Captain Noble. I think we have in the Library a determination of the rotation period of Venus, and a map of the planet made by two observers of the Belgian Royal Observatory, in which they come to very different results indeed to Mr. Lowell. It is not so many years ago that M. Niesten sent me a copy of this; but I must say the details shown on the map of the planet and this period of rotation are widely inconsistent. The two Belgian observers show markings with sufficient distinctness to make a map of the planet; but the result of their mapping and of their observation was that the period of the planet's rotation was really something under 24 hours instead of being 224 days. I do not think the observations of Mr. Lowell settle the question by any means.

The President. Our thanks are due to Mr. Lowell, not for having settled the question, but for raising it. Considering there is such a divergence of opinion as to whether the period of rotation of the planet is 24 hours or 224 days, we ought to have something to settle this point. This does re-open the question, and that is something towards getting at the truth.

A Fellow. I think some question was raised two years ago by Schiaparelli, who found the time of the rotation was the same as the time of the revolution. That observation seems to have been overlooked. I am speaking from memory, but I think a distinct observation was made by Schiaparelli many years ago, and the observation of the Belgian observers was made to disprove that.

Mr. A. Taylor. I think that is so; the observations of the Belgian observers were made for the purposes of criticism. One night a marking on the planet will be seen, and the next night it will be seen to have moved a short distance. Schiaparelli assumed that it had only moved that distance, but the Belgian astronomers assumed that it had made a complete rotation or a little more or a little less.

Prof. Turner. I do not think that Mr. Lowell intended in his paper to ignore Schiaparelli's work.

Sir Robert Ball. One paper on the list is from *Mr. A. Y. G. Campbell*, one of the most distinguished men at Cambridge during the last few years, who sent in an essay which won the Smith's Prize, and this formed a contribution so valuable to theoretical astronomy that he was urged to have it published. He has drawn up a paper and requested that I would deal with it as I thought best. He cannot do so himself, because he has gone to India, having recently been appointed an Indian Civil Servant. The paper relates to the question of the variation of the Arbitrary Constants in theoretical astronomy. It is well known to those who follow the subject that Lagrange established his very famous method of determining the perturbations of the orbit of a planet by a principle which he called the Variation of Arbitrary Constants. [Sir Robert then described Lagrange's method on the blackboard.] Lagrange obtained equations for the variations of these Arbitrary Constants depending on the disturbing forces, in which he used, on the right-hand side, certain functions (fifteen in number) called Lagrange's parentheses, and concerning which he found the remarkable result that they are independent of the time. The computation of these is very laborious, and Mr. Campbell is the first, I believe, to point out an improvement, which considerably shortens this work. I am sure Lagrange himself would have been delighted had he been able to see the step forward that Mr. Campbell has made. Mr. Campbell has shown that, instead of computing these fifteen quantities, they can be reduced to six new functions. Each of these new functions is an extremely simple one, and by a certain artifice he can express all the determinations of the quantities in these new functions. [Blackboard.] That makes a most marvellous simplification in the planetary theory, because it is only necessary to compute these six functions, and then one has these wonderful parentheses of Lagrange. I think this is a most important step, and I am glad that Mr. Campbell has been able to bring it before this Society.

The President. This is not the sort of paper that we generally have here, and it is the kind of thing that very few would care to discuss without some study of the method; but I would ask the Society to return their thanks to Mr. Campbell for his valuable contribution to astronomy.

Dr. Gill. The Society has always taken a considerable interest, and a very kind one, in the work of the Cape Observatory, and they generally ask me to say what I have been doing. The last time I met you I said I was not going to speak upon work we were going to do, but now I wish to show that certain definite progress has been made in the way of publishing our results. The first report is that of the Geodetic Survey of South Africa. The chief worker in this matter has been a Fellow of the Society, Col. Morris, but a very considerable portion of the labour of preparing the book for the press has fallen upon myself. The results are not without some interest. They appear to show that no survey work is free from abnormal variations in the direction of gravity. There is a fair agreement in showing that the curvature and form of the Earth in South Africa is represented by Bessel's elements rather better than by Clarke's. This is more marked in longitude than in latitude. We look forward soon to an extension of these arcs into the territories which are coming under British sway in South Africa, and I hope next time I come home to be able to give an account of the prolongation of this for 6 or 7 degrees. With regard to the next work which has been recently passed through the press. For some years we have been occupied at the Cape in making a preliminary photographic survey of the heavens. It was begun in 1886, and after a number of years, when the photographic work was finished, it was necessary to proceed to the measurement and reduction. Professor Kapteyn undertook that work, and here is the third part of it. The first volume contains the places of 152,000 stars, and Professor Kapteyn has undertaken in addition the immense labour of giving the references to all previously existing observations of the stars. The next book which I hand to the Society is the second volume of the observations of Iris, Victoria, and Sappho, which were made for purposes of my investigation of the solar parallax. The second volume contains a description of the instruments and methods employed.

This volume contains the details of the heliometer observations, and Dr. Auwers' discussion of the places of the comparison stars, which were derived from the meridian observations at 22 different observatories. The rest of the work will follow in another volume. This is a combination of the work of many individuals.

The President. I feel sure you will all join with me in congratulating Dr. Gill on the magnificent work he has brought before us here to-night, or rather the printed evidence of that magnificent work. I have never been much of a believer in his 'Durchmusterung,' as Dr. Gill knows, but it is very pleasing to find that he has got this huge investigation into the excellent form that we see here. The last time Dr. Gill was here I asked him to tell us what he proposed to do, and I remember he then told us of what he had done. Cannot you, Dr. Gill, tell us something about the future? I like a man to give a hostage to fortune; although we know in this case the result will be all right.

Dr. Gill. I will tell you what we are going to try to do. As you all know, a valuable addition has been made to the resources of the observatory by the presentation of a telescope by Mr. Frank McClean. That instrument will consist of two refractors of 22½ feet focal length, one of them with an aperture of 24 inches corrected for photographic rays, and another with 18 in. aperture not so corrected. The gift also includes a prism of 2 ft. aperture, having a refracting angle of 7½ deg., and the question is how this apparatus can be best employed. After discussion with Mr. McClean, and following the advice of other friends interested in physical research, the programme we propose to carry out is this:—First, in astronomical work, we propose to begin with what may be called the qualitative photography of the stars of the Southern Heaven. Whether we shall begin with the 4th mag. or brighter stars is not yet determined. We shall devote a year to photographing the spectra of stars with an objective prism. At the same time the large spectroscope, which has 3 prisms of angles of over 60 deg. and collimators of 2 in. aperture, will be devoted to examination of metallic spectra and such artificial spectra as may be available in the neighbourhood of "G," or sufficiently near to G for the determination of motions in the line of sight, and with our qualitative spectra and the prism we shall be able with a little research to find those rays suitable for that work. That being determined, it is proposed to determine the velocity of the stars in the line of sight of that order of magnitude which is capable of being photographed with a short amount of exposure. The spectroscope is made in such a way that it can be enveloped in non-conducting material, so that changes in the atmosphere will be reduced to a minimum, and by that means we shall be able to obtain longer exposure, and perhaps get fainter stars than we might otherwise through such a thickness of glass. The spectrograph will be fitted with a prism of 60 deg., to be used on the large photographic telescope for other work. That is the programme we have laid down at present, and one which one may hope to begin and end in another six or seven years. I hope to be provided with a new transit-circle mounted in a proper observatory, with which we shall be able to turn out observations freer from systematic errors than we can do with the instrument at present in use. This work will be devoted to a comparatively small fundamental catalogue. Next there is the catalogue, the formation of which was resolved on at the International Astronomical Conference last May. Then we shall, with the co-operation of certain other observatories, including those of Cambridge and Edinburgh, observe between 2000 and 3000 stars which I have carefully selected—zodiacal stars whose places, being thus determined by a great number of observatories, ought to be known relatively towards each other with very great precision; and we shall observe the planets with the heliometer, and thus, I think, their places can be determined with a very high degree of accuracy. The difficulty with a good heliometer is not to determine the planetary places relatively to the stars, but it is to get the exact places of the stars themselves, and that can only be done by the co-operation of observatories. That is as much as we can undertake. I hope we shall be able to make the new instrument a valuable aid to science.

The President. I understand that Dr. Gill goes back to work to-morrow. I am sure that he takes with him our most hearty congratulations and good wishes. When I say congratulations, I think he is entitled to our most sincere congratulations, for I think he is a most fortunate man. It would have been the greatest pity in the world if a man with such love, energy, and zeal for his science as Dr. Gill has, had not the capacity for carrying out his wishes. This fortunately has been granted him by the magnificent offer of Mr. Frank McClean. I think we are lucky in having such a man as Dr. Gill to work this instrument; and I am pleased that Dr. Gill has been able to impress on the Admiralty the necessity for more help. [Applause.]

Prof. Turner said that a paper had been received from Prof. Barnard in reply to papers that had been read by Dr. Roberts. Prof. Barnard objected to the criticisms of Dr. Roberts, and went through them in detail. In the first instance he particularly objected to one comparison of a photograph taken by himself, where a star quite near the edge of the plate was selected for comparison with some of the best work of the reflector. In fact Prof. Barnard at first could hardly believe that this was the plate selected by Dr. Roberts for comparison, and in his paper assumed that a mistake was made. He had, however, sent tracings to Mr. Wesley, and it had been found that they agreed in date with the positive, and that no mistake had been made. Prof. Turner then read the summary of the paper.

The President. This is a paper of a controversial character, and Dr. Roberts will, no doubt, explain the little discrepancies which Prof. Turner has alluded to. The subject is an interesting one, and it is of the highest importance that proper means should be taken to get correct results in every case.

The President. We have with us to-night a good many of the observers who went out to view the last eclipse, and no doubt the meeting would like to hear some of their experiences. I will not ask for the results they obtained.

Mr. Stone. I hope to lay the results we have obtained before you at the December meeting. Sir George Baden-Powell will attend himself, and I hope he will have something to say.

Sir Robert Ball. I really have nothing to say, for, as Dr. Common says, I was only a looker-on. I see that Mr. Green is present, and I think that you should have called upon him. We certainly had an extremely pleasant trip. I think most of us agree that though we failed to see the corona we did see a great many things which were of very great interest to us. First there was an instrument which gave us much pleasure to see, viz., this new coelostat, which, as we had seen it only in this room, we knew comparatively little of. The erection of this instrument at Vadsö, which occupied a week, was a matter of instruction for most of us. I greatly enjoyed it, and learned a great deal with regard to it. Next we had the privilege of going to the other side of the Fiord and seeing Prof. Lockyer's instruments. He had 75 men of H.M.S. 'Volage' trained to take part in the eclipse; but, unfortunately, the clouds prevented them seeing anything. I cannot say that we saw nothing: we could not see the exact moment when the Moon began to encroach on the white disc; but almost immediately after the eclipse began the clouds began to clear, and fully twenty times between that and the advent of totality the clouds lifted and we were able to see the advancing disc of the Moon. I had a small telescope—an equatoreal belonging to the Cambridge Observatory, which I took out with me—and I could see through this the gradually diminishing arc; but, finally, as the arc got extremely small those clouds got very thick, and it was almost impossible to see when the final extinction of the arc took place. I think the clouds had more to do with the final extinction than the Moon. Then there was that splendid spectacle—the shadow traversing the landscape. From where we were situated, on a hill at Vadsö, we were able to see 20 miles up this Fiord, and the shadow, as it came down over the Fiord, was a very impressive sight, the lines showing out brilliantly, and then when the shadow had passed the region left was all in darkness; but we noticed a circumstance that I had heard of before, and that was that the disappearance of the darkness was a much more instantaneous phenomenon than its coming on. We did not see the corona, for it was totally invisible. Then it was very interesting to us to visit the various observatories in the neighbourhood. Half a mile away from Dr. Common's observatory Dr. Copeland had his tremendously long tube of 40 feet, with a small object-glass, and with photographic plates 18 inches square, with which he was going to take photographs. Then there was Prof. Angström, a Swedish astronomer, who had a most beautiful apparatus, but I do not think he saw any more than we did. I think it was as clear at our station as at any adjacent station. One of the party, I think, saw a star during totality, but that is all.

The President. I can corroborate what Sir Robert Ball has said. I see Mr. Christie is present, and I think we shall all be pleased to hear what he can tell us of the expedition on which he went.

The Astronomer Royal. I have only to say that we spent three or four months of our lives on the expedition to Japan, when we certainly saw some very interesting sights, but we did not see the sight we went for. We did not see anything of the eclipse, and we have come back without any results. The only result of our journey is that I think we have all gained some experience, and perhaps that may be of some use, because I think all those who have been out to this eclipse are fired with the idea of taking a snap shot at the solar corona on some other occasion. There will be another opportunity in about twelve months. The whole of the party hoped that the work we have been doing in connection with the late eclipse will be available for the purposes of observing the eclipse which will be visible from India in 1898. Prof. Turner and Capt. Hills started away about three weeks before I did. I was unable to go with them owing to the date at which the Greenwich Visitation is fixed. They, however, prepared everything at the station, and I wish to take this opportunity of expressing my great obligation to them for all they did in the way of getting over preliminary difficulties. We have found that it does not do in these eclipse expeditions to cut things too fine. I had a very uncomfortable time in crossing Canada, because the Canadian Pacific Railway had broken down through what are termed "wash-outs"; and the question arose in my mind whether I should not have to go back when I got to Vancouver; but I managed to get there the day before the vessel sailed. In Japan the British Minister, Sir Ernest Satow, took a great interest in the expedition, and did everything in his power to help us. He had made such excellent arrangements, that with the assistance of Admiral Buller, who also helped us in every possible way, I was able to reach the station in time to join Prof. Turner and Capt. Hills, and we succeeded in getting our instruments mounted with the help of Japanese carpenters, who, by the way, insisted upon turning screws round the wrong way and in doing everything left-handed. We had a full-dress rehearsal the day before the eclipse, and put in plates and made exposures as if the eclipse were actually occurring, and found everything went without a hitch. We were therefore in high spirits, because it was a lovely day on that occasion. On the day of the eclipse, however, there was first fog and then clouds. We got glimpses of the Sun at intervals, up to within about 20 minutes of totality; but then the clouds settled down and we saw nothing more; so that the expedition was a total failure so far as that goes. This has been a great disappointment to us, as it naturally has been to other expeditions, except to that which went to Nova Zemlya; but we feel that we have gained some experience. We learned that a certain amount of time is required to get things into perfect order, and we also contrived arrangements that very greatly simplified the adjusting and focussing of telescopes, and found that a much higher degree of accuracy could be attained in these matters by means of the coelostat and the employment of those excellent mirrors that our President had provided for us. I think that the use of these plane mirrors is a very great step in the work of eclipse expeditions. By means of these one can focus entirely independently of stars. The method is to have a little hole at the back of the plate in the plateholder, covered with a network of gauze; and behind this a candle is placed, so that its light passing through the hole is reflected from the mirror, and an image of the gauze is formed on the photographic plate. This hole was made near the centre of the field, in the upper half of the plateholder; the plate was cut in half, and the image was formed in the lower half. By moving the telescope we could form images on different parts of the plate, and by examining these images could find whether the instrument was in focus or not. With my instrument I used a secondary magnifier. Professor Turner had the twin-telescope, and he also used the secondary magnifier. By this means we found we could get extreme accuracy in focussing independent of the weather, which is a matter of importance in eclipse work. I have two photographs of this gauze network taken with a telescope of about 8 ft. 6 ins. focal length, in positions the distance between which was 8/1000ths of an inch, and the difference between the two photographs is quite marked. You can see that one photograph is in decidedly better focus than the other. There is one point about this which may be mentioned, and that is, as the source of light and the plate are both moved by a change of focus, the effect of any error in focussing is doubled. A change of 1/100th of an inch in focus of 9 ft. was very marked and one can be quite certain of being within half that quantity.

It may be of interest if I give some account of our return journey. I always felt that in this expedition I had two strings to my bow, and that even if we should be unfortunate as regards the eclipse, it would be a great advantage to me to see something of American observatories and of American astronomers, and that was the great consolation we had for our failure. We were enabled in returning through America to make the acquaintance of a number of astronomers whom we have learned in this society to appreciate so highly by the work they have done, and to see the instruments and appliances they have at hand. We paid a visit to Chicago and were received with extreme kindness and courtesy by all connected with the Chicago University, especially by Professors Hale and Barnard. Unfortunately we did not see Mr. Burnham. We were very much impressed by our visit, for we saw things on the large scale which Americans are in the habit of adopting. I think I may safely admit that we were shown the biggest thing in observatories in the world, the Yerkes Observatory. The building is a beautiful one and possesses a fine telescope, the largest refracting telescope in the world, of 40 inches aperture. We were a little disappointed when we found that we should not be able to see it erected *in situ*. There have been delays which are not unusual in such things, but it is expected that it will be completed by next year. We, however, saw enough to convince us that they have a magnificent institution for astronomical research and very fine instruments. What is equally and perhaps even more important is that they have men who are able to use them as they should be used. It was extremely pleasant to meet such men as Professors Hale and Barnard. From there we went to Harvard College and enjoyed a delightfully interesting visit to Professor Pickering, who showed us all the work he was doing. It is necessary to go there to appreciate properly all the work that is being done at Harvard. I should not like to attempt to give any exact account of the work that Professor Pickering is doing beyond saying this, that his idea is to appropriate the whole of astronomical photometry, and he is carrying out that idea in a very complete and excellent manner. I was very curious to see what work he could do with his photographic doublets. He has a 24-in. doublet already mounted, and it is a matter of the very greatest importance in the development of astronomical photography to compare results from the photographic doublet with those from the photographic object-glass. I was very much struck with the character of the images given by this object-glass and the way in which a large field was covered satisfactorily—a field a good deal larger than one can get with the ordinary achromatic object-glass. But what struck us more than anything else was the man who was directing all this work and the wonderful energy and skill he showed in organizing it and carrying it out in such a successful way. It seemed extremely difficult to imagine how any one man could manage to keep so many different branches of work going satisfactorily; and I am sure the Fellows of this Society will feel that Professor Pickering deserves the thanks of astronomers for the enormous amount of work he is turning out from that observatory. We next went to Boston and then paid a very interesting visit to Professor Newcomb at Washington. The observatory, which has lately undergone some alteration, is a very fine building.

The 26-inch telescope has been remounted, and it is contemplated to reorganize the staff. It was of the greatest interest to us to have the opportunity of talking over with Prof. Newcomb the work he is engaged upon and the work he contemplates. He is full of energy, and I hope that that energy may be utilized for a long time in the service of astronomy. It was rather a grief to hear that his connection with the Washington Observatory and the American 'Nautical Almanac' was likely to be severed, and one cannot help feeling some anxiety as to what will be the future of those institutions when the time comes for the able men connected with them to retire in accordance with the rules of the service.

Prof. Turner. I should like, first of all, to say that I take the same point of view as the Astronomer Royal. I do not think it can be too strongly stated that the one important fact that has come out from this disappointing eclipse—with the exception of the observations made in Nova Zemlya—is the very great value of the coelostat in the form in which we have been using it. The great bane of eclipse-observers has been their dependence upon the fitful weather which might precede the eclipse. I remember, in the eclipse of 1886, what weary waiting there was for fine weather to make the preliminary adjustments; in fact one gentleman, whose duty it was to observe Polaris, went on the roof to do so, and they found him asleep there in the morning. In 1887 there was the same difficulty. We had very fitful weather beforehand, and I saw the Sun only on one occasion in the week preceding the eclipse. It sounds rather a rash statement, but I do not mind saying that I feel I could now go out and take photographs with the coelostat, and have everything in perfect adjustment on the day of the eclipse, if I could only see the Sun for 5 minutes on any morning, or any star of which the declination is known. I make the statement with some confidence—that the adjustment of the coelostat can be carried out with one view of the Sun, which must not be too near the meridian. To have brought eclipse-work to this position is a great step in advance, and although we did not see the eclipse we have obtained results of the greatest value. As to our return-visit, I can only emphasize the admiration which has been expressed for the work that is done in Harvard. If one examines the immense number of volumes Prof. Pickering has produced, this will be well understood.

Capt. Hills. I do not know that I have very much to add to what has already been said, but I must dissent from what Prof. Turner said last, that a glimpse of the Sun for five minutes is sufficient to enable an eclipse observer to adjust his instruments. As a spectroscopic observer I say that is not enough. The work I was going to do was somewhat on the same lines as my observations in 1893, but with a very much improved instrument. I intended to photograph the spectrum of the corona with the ordinary form of spectroscope, and I was going to try and photograph the spectrum of the reversing layer near the G line. I adjusted one of the telescopes so that the slit would be exactly tangential to the Sun's limb, just about the point where the crescent would disappear, and then made a series of exposures, beginning before totality and continuing until about 15 seconds after totality. I arranged with Prof. Turner to give me a signal 15 secs. before totality, which he would know by calculating beforehand the size of the crescent that could be seen in his telescope. At the end of totality I should have shifted the telescope so as to get the other limb tangential to the slit and so get the other point of contact. On the former occasion this worked perfectly, and it would have shown distinctly if there was a prominence at that point. During totality at this recent eclipse I exposed plates in both instruments to the sky on the chance that there might be light enough to give indications of the spectrum, but there were no such indications. I hope I shall have an opportunity of using the same instruments again shortly and I trust with better results.

The President. By accident we succeeded in getting one photograph of the eclipse. Sir Robert Ball was keeping the time at Vadsö and owing to obscurity he gave the signal for totality a few seconds too soon, and Mr. Hinks, who was in charge of the twin telescope, promptly exposed a plate, so that he got a picture of the partially eclipsed Sun shown as a very fine crescent. It showed that the focussing and all the adjustments were perfect, and is the one visible proof that we did actually go to Norway to observe the eclipse.

Mr. F. McClean read his paper on "Photographic Spectra of Types III. and IV., and also of the Variable Star β Lyræ."

The following papers were announced and partly read :—

E. P. Sells. "Physical Observations of Jupiter made at Adelaide Observatory, 1884–93."

E. E. Barnard. "On the Comparison of Reflector and Portrait Lens Photographs."

Royal Observatory, Edinburgh. "Observations of Comets and Planets."

J. Tebbutt. "Observations of Phenomena of Jupiter's Satellites at Windsor, New South Wales, 1896."

Maxwell Hall. "The Sidereal System, revised in 1896."

A. W. Roberts. "Proper Motion of the Southern Short Period Variables L Carinæ and K Pavonis."

Percival Lowell. "Determination of the Rotation Period and Surface Character of Venus; and Note on Observations of Mercury."

A. Y. G. Campbell. "On the Variation of Uncanonical Arbitrary Constants; with an Application to the Planetary Theory."

F. McClean. "Photographic Spectra of Types III. and IV., and also of the Variable Star β Lyræ."

Royal Observatory, Greenwich. "Observations of Comet *f* 1896 (Perrine)."

Royal Observatory, Greenwich. "Mean Areas and Heliographic Latitudes of Sun-spots in the year 1894, deduced from Photographs taken at Greenwich, Dehra Dûn, and Mauritius."

E. J. Stone. "Note on the Effects of Distances upon the Spectra of Physical Clusters of Stars."

Radcliffe Observatory, Oxford. "Observations of Comet Perrine, 1895 IV., and of Comet Perrine, 1896, Nov. 2."

C. K. Charlier. "Exposition of a General Theory for constructing Astronomical and Photographic Object-glasses."

The following gentlemen were elected Fellows of the Society:—

Lewis Evans, J.P., F.S.A., Barnes Lodge, King's Langley, Herts; *John Anderton Greenwood*, LL.M., B.A., Brooklyn, Earl's Court Square, S.W.

The following Candidates were proposed for election as Fellows of the Society:—

William Johnston, St. Nicholas House, Westgate St., Gloucester (proposed by J. M'Carthy).

George Edward Lumsden, Assist. Sec. of the Province of Ontario, 57 Elm Avenue, Toronto, Canada (proposed by S. W. Burnham).

Major Percy Alexander MacMahon, R.A., F.R.S., Artillery College, Woolwich, and 52 Shaftesbury Avenue, London, W. (proposed by A. A. Common).

Louis C. H. Maston, Banker, San Francisco, Cal., U.S.A. (proposed by H. H. Turner).

Beauchamp Prideaux Selby, J.P., Pawston, Cornhill-on-Tees (proposed by John Browning).

J. E. de Villiers, Government Surveyor, Cape Town (proposed by David Gill).

John Watson, Norman Villa, Glossop Road, Sheffield (proposed by W. J. B. Roome).

THE BRITISH ASTRONOMICAL ASSOCIATION.

The Annual General Meeting of the Society was held at University College, Gower Street, on Wednesday, October 28, the President, *Mr. E. Walter Maunder*, in the Chair.

The Minutes of the previous Annual Meeting were read and confirmed. The receipt of a number of presents was announced, and the names of 67 proposed new Members were passed for suspension. The President remarked that this was the longest list ever presented at one Meeting. Of these names 24 had been sent in from the East of Scotland branch.

The Secretary read the report of the Scrutineers of the ballot for the Council *.

Dr. Downing, Secretary of the Eclipse Committee, presented and read extracts from a lengthy report upon the Eclipse Expedition arranged by the Association.

The President then delivered the annual address to the Association, in the course of which he said:—"The business of the Association is the furtherance of astronomy in all its branches, not in one alone, and perhaps our most serious danger is lest we should cultivate certain of these branches to the neglect of others. If then, for a second time, I ask your special attention to the subject of eclipse observation, I would be by no means mistaken as if I considered this of paramount importance to the Association. Rather, if we had to make a choice, and it were found impossible to continue our routine sectional work and to engage in eclipse observation, there could not be a doubt as to which should be bidden to 'stand by.' The purpose, the meaning, the justification, I might say the fame and glory, of our Association lies mainly in the efficiency of our Observing Sections. The noble record of work done which Miss Brown, Mr. Corder, Mr. Elger, Mr. Green, Mr. Waugh, and our other Directors have so regularly laid before us, must ever be our chief boast.

"But just because our Sections are, for the most part, in healthy and vigorous action, a strength and an honour to our Association, and a source of solid scientific usefulness, I think it may be advisable on an occasion like the present to turn rather to matters which are of a more exceptional character.

"And first you will, I am sure, desire that I should speak of the eclipse that is over. You all know that in one sense our expedition was a failure. But there are failures and failures. There are failures in which the men have failed; failed in energy, failed in skill, failed in cordial co-operation. Such failures are failures indeed. It is no record of defeat like this that we have to bring back to you. In these respects we can claim success, full success. We have shown that it is possible for a large number of independent workers to unite together, to travel to a distant country for a common purpose, to work in the most absolute and cordial co-operation, to divide amongst themselves a great number of important observations so that none should be neglected, to submit to arrangement and drill, and to carry out instructions to one common end; and the whole in a spirit of hearty good fellowship, of ready courtesy, of true friendship, which, to my mind at least, will ever remain the most vivid memory of our voyage to Varanger Fjord.

"Next, to my own mind, was the fact that here, for the first time, the Association was seen in the concrete, as an active, living, working body. It may be, perhaps, a little difficult to convey the exact impression on my own mind, but if you will bear with me I will try and explain what I mean at greater length. The Directors of the Sections will, I am sure, pardon me if I take as an example the one presided over with so much devotion by their doyen, the Rev. W. R. Waugh. Here, in the Jupiter Section, we have a remarkable example of the real vitality of the Association. We have scores of workers, producing at each opposition hundreds of sketches and other observations. There is no possibility of doubting the life, energy, and usefulness of such a Section.

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* In the list of the Officers given on p. 413 of our last number, the names Rev. A. L. Cortie, J. D. Hardy, T. Lewis, and Rev. W. Sidgreaves should have been omitted.

"But though we see the results of the Section, we do not see the Section itself. We never have—the more's the pity—the opportunity of seeing the Members of the Section assembled in conference, presided over by their venerable Director. The Jupiter Section is not seen in the concrete.

"The old proverb says that it is no use crying over spilt milk, and the great Baron Rothschild on one occasion remarked that all men make mistakes, but it is the foolish man that makes them twice. The most emphatic lesson of the past eclipse is the absolute need of occupying every available station, no matter what its meteorological record; that record in the case of Nova Zembla was almost prohibitory, yet, nevertheless, Nova Zembla and Bodö, most assuredly neither of them places to occupy in preference to Yezo or Vadsö, were favoured, whilst the stations whither so many observers had gone were not.

"We are looking forward now as well as backward. 'The king is dead, long live the king.' The eclipse of 1896 is past, that of 1898 is coming on. We occupied but one station in August 1896, we must occupy many in January 1898, and—and this is the moral which I wish to draw from all that has preceded—that we may make provision for so doing, we must know at the earliest possible date who are likely to take part in such an expedition.

"To turn from the subject of eclipses to the welfare of the Association generally. It is, I think, a subject for legitimate congratulation that the Association still continues to increase its numbers. The list of candidates read out to you at this meeting is, I believe, the longest that your Secretaries have yet had to present to you, and itself more than counterbalances the losses by resignation or death we have sustained during the entire year.

"So far, things are most satisfactory. It is satisfactory also to report that a new Branch is in process of formation in the East of Scotland, with its headquarters at Edinburgh. Then there has been, I think, a steady and most unmistakable growth in the interest and vitality of our meetings. In the early days of the Association it was found necessary to arrange for lectures or addresses to be given in order to supplement the papers supplied by the Members. Now, on the other hand, we habitually find that the roll of papers can with great difficulty be got through in the two hours at our disposal, and many of the papers thus contributed contain much freshness of interest, and are contributed by young Members who have made their first entries into astronomical circles through the Association.

"In one thing I would ask for a further improvement. The number of Members of our Observing Sections increases indeed, but by no means so rapidly as the general membership. This, I think, is a great pity, but it probably arises from new Members being diffident of associating themselves with experienced workers. I feel sure, however, that new Members will receive a very hearty welcome from the Director of any Section to which they wish to attach themselves, and that they will meet with help and encouragement, not coldness or criticism, if they thus come forward. I would further remind casual observers, those who have instruments, but who have not the time to devote them to regular study, that when they are able to make observations the fact that they are occasional and not systematic should not hinder them from communicating them to the Director of the appropriate Section. Who knows but that, in some cases at least, they may come most opportunely to fill up gaps in regular series?

"I would press this point home, and especially upon the younger Members of the Association—younger in either sense, those who joined more recently, and those who are younger in years."

Col. Burton-Browne made some remarks relative to the eclipse of 1898. He said that he was collecting meteorological notes about the stations along the line of totality.

Votes of thanks were accorded to the retiring Members of Council, the Scrutineers, and the Auditors. Dr. Downing then proposed a vote of thanks to Mr. Maunder, the President, and Mrs. Maunder, the Editor, who now retire, which was carried by acclamation.

ROYAL METEOROLOGICAL SOCIETY.

The first monthly Meeting of this Society for the present Session was held on Wednesday evening, Nov. 18, at the Institution of Civil Engineers, Great George Street, Westminster, *Mr. E. Mawley, F.R.H.S.*, President, in the chair.

Mr. W. Ellis, F.R.S., gave an account of the proceedings of the recent International Meteorological Conference, which was held at Paris from September 17 to 23. The conference was attended by about forty representatives from various parts of the world, Mr. Ellis being the delegate from the Royal Meteorological Society.

The Hon. F. A. Rollo Russell read a paper on "Haze, Fog, and Visibility." Haze is most prevalent when the wind is from the north-east, and is due probably to excess of dust brought about by conflicting currents. The causes of fog are to a great extent the same as the causes of haze, although radiation in certain states of the air and ground plays a more conspicuous part. The main cause of fog is mixture of airs of different temperatures; and the attainment of a size of water-particle so much larger than in the case of haze is due to suddenness of mixture, greater humidity, or greater differences of temperature. The conditions favourable to visibility are dryness of the air near the ground-level, uniformity of temperature and moisture, radiation below the mean, steady and homogeneous winds through a great depth of the atmosphere, approximation of the temperatures of sea and land, and a number of dust-particles less than the mean.

François Félix Tisserand.

We have not yet reached the end of the present year, and already we are looking back over its records.

Two great events hold our attention. The one, an International Congress presided over by M. Tisserand (May 11 to May 15), whose earnest desire was to bring to a happy close, with the ending century, the work of the photographic survey of the heavens. The other, the sudden death, on October 20, of the Director of the Observatory of Paris.

François Félix Tisserand was born at Nuits Saint-Georges (Côte-d'Or) on January 13, 1845. At the age of eighteen he entered the "École normale supérieure" of Paris, Section of Sciences. The companions of his youth, whose friendship he enjoyed up to the day of his death, had a foreshadowing in 1863 of the development of M. Tisserand's rare qualities.

In 1864 he took the diploma of "Licencié es Sciences mathématiques"; the following year that of "Licencié ès Sciences physiques"; in 1866 he entered the Observatory of Paris with the title of Assistant Astronomer. Twenty-six years later, on the proposition of the Académie des Sciences, he was chosen by the Minister of Public Instruction as the successor of Le Verrier, Delaunay, Mouchez.

In 1868 he took part in the French Expedition to Siam for the observation of the total eclipse of the Sun on August 18. M. Tisserand's love of study called forth this remark of M. Janssen on the occasion of their voyage to the East:—"While we others were admiring the sea and harbours, M. Tisserand, disdainful of all distractions, was absorbed in the works of d'Alembert."

The same year he was received as doctor in Mathematics for his dissertation: "Exposition, d'après les principes de Jacobi, de la méthode suivie par M. Delaunay dans sa théorie du mouvement de la lune autour de la terre."

In the reports of the Académie des Sciences for 1869 we find the first of his scientific papers, which extend over twenty-seven years, covering the ground both of theoretical and practical astronomy. The reader has but to look through those numerous volumes in order to form an idea of the work accomplished by M. Tisserand during his short life. Let him turn from the index tables to the papers signed "Tisserand," and he cannot fail to wonder at the works achieved by this powerful intellect.

In 1870, after a careful study of one of Lagrange's memoirs, M. Tisserand makes a practical application of the master's thought to the formulæ of quadrature employed in astronomy.

In 1872 he studies the motion of the planets according to Weber's electro-dynamic law. Putting the force

$$F=\frac{fm\mu}{r^2}\left[1-\frac{1}{h^2}\frac{dr^2}{dt^2}+\frac{2}{h^2}r\frac{d^2r}{dt^2}\right]$$

under the simple expression of

$$F=\frac{fm\mu}{r^2}+F_1,$$

in which F_1 is considered as the disturbing force, and integrating the equations of motion by Lagrange's method of the variation of constants, he rapidly obtains approximate formulæ of a convenient and practical use.

In 1876, in his note on the "Invariability of the Major Axes of the Planetary Orbits," he says:—"I have noticed that one need but connect Lagrange's memoir with certain passages of Jacobi's celebrated paper on the elimination of the nodes in the problem of three bodies, in order to demonstrate Poisson's theorem in a most simple and satisfactory manner......"

Thus one finds M. Tisserand constantly directing his thoughts throughout those 27 years towards the study of the mechanism of the heavens. This concentration of will-power destined him to fulfil the functions of Professor, Director, Member, and President of various scientific institutions and societies, both French and foreign. In 1873 he became Director of the Observatory of Toulouse, and Professor of Astronomy at the faculty of sciences of that city. In 1874 he was made a Corresponding Member of the Académie des Sciences of Paris. In 1874 and in 1882 he took part in the expedition for the observation of the transit of Venus. In 1878 he succeeded Le Verrier at the Académie des Sciences; he was elected Member of the Bureau des Longitudes, and Professeur Suppléant at the Sorbonne.

At the age of thirty-eight he was appointed to the chair of celestial mechanics of the Sorbonne, left vacant by the death of Victor Puiseux. There, at the University, he expounded to his pupils, of whom the undersigned was one, the theories of the planetary system; again and again he returned to the general principles that lie at the basis of the methods which he developed in a simple and sure manner, levelling difficulties, filling up gaps, transforming demonstrations, rendering them clear, elegant, simple.

The outcome of his toils was, among other contributions and discoveries, the 'Tisserand criterion' and the 'Traité de la Mécanique céleste' in four quarto volumes, which stands side by side with Laplace's 'Mécanique céleste.' M. Tisserand's treatise[*] is one of those inestimable books which rapidly spread abroad acquired truths, awakening slumbering talents, sowing the seed for an ample harvest.

In 1892, when death put an end to the career of Admiral Mouchez, the directorship of the Paris Observatory was entrusted to M. Tisserand. During his four years' administration (1892–1896) he took an equal interest in the different departments of the work of the Observatory. The results summed up in the annual reports show that the promise given in these words, spoken by M. Tisserand at the meeting of the Council of the Observatory on January 14, 1893, "Called to the honour of succeeding Admiral Mouchez, I shall neglect nothing to bring to full completion an undertaking which is an honour to our country and which at the same time serves to benefit science," has been fully kept.

Paris, 1896 Oct. 29. DOROTHEA KLUMPKE.

On the Level of Sun-spots.

[Continued from p. 398.]

THE evidence from thermal absorption that Sun-spots are situated above rather than below the level of the photosphere is perhaps the strongest that can be at present adduced. It may be stated quite simply. Measurements by Langley, by the writer, and by W. E. Wilson have furnished quite accurate tables[†] showing the decrease in the intensity of the thermal radiation at different distances from the centre of the Sun's disk to the limb. The law of this absorption as found by experiment agrees quite satisfactorily with the theoretical law of Laplace after a suitable correction to make it accord with modern physical views.

The three observers mentioned have also measured the intensity of the thermal radiation from Sun-spots as compared with that from equal areas of adjacent photosphere. Now when a spot passes by the Sun's rotation from a point near the centre of the disk towards the limb, it is found that the relative intensity of the spot increases. This might mean either that the radiation from the spot was greater, or that from the neighbouring photosphere was less. But with our table showing the increase of absorption over the photosphere from the centre of the disk outward, we can readily reduce our ratio to what it would be if the comparison area of photosphere were constantly at the centre of the disk. On doing this we at once see that the thermal absorption over spots does not increase as we approach the limb in nearly the degree that is the case with the photosphere. The reasonable inference from this is that the spots are at a higher level than the photosphere, and hence less subject to the absorption of the Sun's atmosphere.

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[*] Radau, 'Bulletin Astronomique,' t. vi. 1889, p. 15.

[†] Collected on p. 302 of the new (1895) edition of Young's 'The Sun.'

Still further, Langley and the writer have found instances in which the measured radiation from spots very near the limb *exceeded* that from the neighbouring photosphere. As compared with an area of photosphere near the centre of the disk, however, the radiation of the spot is always the less; as would be expected, unless we were to adopt the view, improbable in itself and contrary to these observations, that with the solar atmosphere removed Sun-spots would be actually more radiant than an equal photospheric area *. We are therefore again led to the conclusion that the level of spots is higher than that of the photosphere, so that less absorption occurs over the spots, making them in some cases appear to radiate more than neighbouring areas of photosphere.

Thus far the spectroscope has not been called in witness in the case before us. A testimony from it contradictory to the view whose merits we are stating might well be considered fatal to that view; a favourable testimony would not be as convincing as an unfavourable one would be damaging.

Now it would appear that in fact the spectroscopic evidence is not competent to decide the question. The Wilsonian doctrine was accepted long before the spectrum of a Sun-spot had been examined; and when such examination was made, no contradiction was found. The spectrum of a spot shows firstly a general absorption, and secondly a selective absorption, not produced by smoke or solid particles, but, as has been pointed out by Young, Dunér, and others, by gases of less radiating power than the surface behind them. Large numbers of dark lines are broadened where the slit crosses a spot, and narrow down as they extend through the penumbra; others are thinned over the umbra; sometimes those of calcium (H and K always), hydrogen, magnesium, and other metals are reversed: perhaps a majority of the lines are wholly unaffected.

To produce these effects it seems to be quite immaterial whether the absorbing masses of vapour are situated entirely above the photosphere or in cavities in it; in either case the white light that is absorbed is by all considered to be due to the photosphere—from an under stratum of it, according to the depression theory of spots; from its ordinary upper surface, according to the elevation theory. The same spectrum in umbra and penumbra would result from a "convex" mass of gases (say an anticyclone) above the condensed stratum, as from the gases poured into a cavity extending downward partly through that stratum (the photosphere).

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* It will be noted that in this discussion I have not spoken of relative temperature, a very different thing from relative thermal radiation, the quantity measured in such observations.

Arguments might be brought forward tending to show that the conditions in elevated masses of gas would be more favourable for the production of the observed effects, but in our present state of knowledge such reasoning would be based more on theory than on fact, and therefore I prefer to regard the evidence from the spectroscope as at present undecisive.

The query will probably be raised as to the bearing of the view presented in this paper upon the most prevalent Sun-spot theories; those of Secchi, Faye, Oppolzer. The first is summarized by Young as follows*:—"Secchi believes them to be dense clouds of eruption-products settling down into the photosphere *near*, but not *at*, the point where they were ejected." Evidently the validity of this theory is not affected by the adoption of the view that the spots are gaseous masses above the photosphere, finally in their descent settling down upon it.

Faye's theory is based upon the relative drift of contiguous portions of the photosphere itself, due to the equatorial acceleration of the Sun's rotation. It would seem that the vortices might equally well take place in the gases above the photosphere as in that stratum itself. Certainly his view that the vorticular disturbance of the solar atmosphere propagates itself downwards conforms better to the elevation theory.

The Sun-spot theory of Egon von Oppolzer, based upon meteorological analogies, is in many respects a very promising one. To the writer no theory seems satisfactory which does not take into consideration these analogies in the terrestrial atmosphere. With the descent of masses of gas, under solar gravitation, their temperature must rise, at certain levels perhaps being comparable with the photosphere in radiance, even if adiabatic conditions are but imperfectly realized, and this may possibly account for the reversed lines of calcium over spots. Oppolzer's may be called an anticyclone theory of Sun-spots, but its validity seems in no wise diminished if we consider that the descending currents do not penetrate the photosphere, but produce their absorption and run their course entirely above the photosphere.

The considerations that have been brought forward in this paper may seem to many to be insufficient for abandoning the doctrine of Wilson, but my purpose will be accomplished if observers shall give to this still unsettled question the attention that it fairly deserves. E. B. Frost.

Dartmouth College, Hanover, N.H.

Selenographical Notes.

Euler.—This ring-plain is not a striking telescopic object at any phase, but is interesting as an example of a formation which, though regular in outline, has a wall whose altitude above the surrounding plain varies very considerably. According to Neison, the difference between the height of the east and west wall amounts to 1400 feet, the loftiest peak of the latter rising to 2400 feet, while the floor sinks to 6000 feet below it. These figures, judged by lunar standards of altitude, are not very striking, but when we regard the great inequality in the height of the ring which they represent, they become significant and noteworthy. Euler exhibits a very distinct terrace on the outer slope of the eastern wall, just below that particular section of it which is remarkable for its moderate height. May not this feature represent a slip of the material which once occupied the summit ridge? It is true there are indications of outside terraces on the opposite, or western, flank of the formation, but they are far less prominent than that in question, which is so conspicuous under many conditions that it appears to be almost as massive as the neighbouring wall itself. In addition to the terraces, the rampart has some spurs and buttresses on the south side, two of which are easy objects. I believe there is a gap in the border where these abut on it. Indications of this break in its continuity were very plainly seen by me on two occasions when the formation was just within the morning terminator. It is probably due to the presence of a crater. Neison speaks of a gap on the north, but this I have not succeeded in detecting. Euler has a large central mountain, which cannot, however, be termed a prominent feature.

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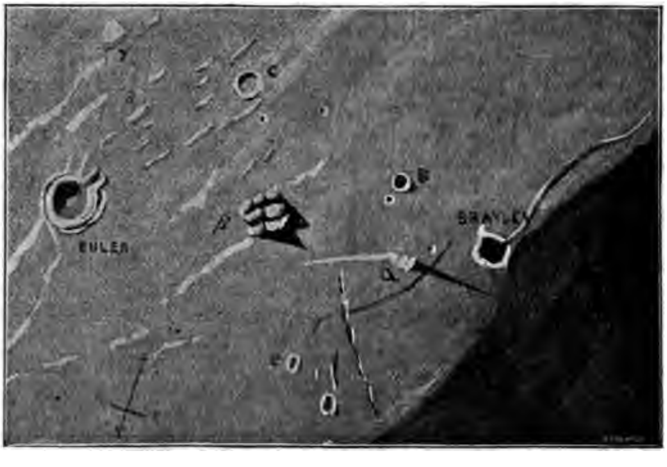
* 'The Sun,' 1895, p. 182.



In the accompanying drawing, made 1896 March 24, $9^h\ 15^m$ to 10^h, with a power of 340 on my 8½-in. reflector, a bright square-shaped enclosure is shown as just coming into sunlight. This is Brayley, a small ring-plain whose border on the south-east is intersected by the northern end of a winding ridge from the south, similar in character to that which traverses the northern wall of Mädler. There is a peculiar expansion in the south-west corner of the border of Brayley, very conspicuous at this phase.

About midway between Euler and Brayley, there is one of the most remarkable isolated mountain-masses in this quadrant of the Moon (β in the drawing). It towers to a height of nearly 4000 feet above the surface of the Oceanus Procellarum, and is made up of at least seven distinct brilliant peaks. It occupies an area of some 300 sq. miles, and appears to rise abruptly from the plain without being associated with any lower elevations or other details. Probably it dates from an earlier epoch than the plain from which it springs. Some distance further towards the east, rather more than halfway between the mountain-mass β and Brayley, will be found the small brilliant triple mountain α, which casts a beautiful spire of shadow at sunrise (this shadow was drawn at $9^h\ 45^m$, on the date above mentioned). This object is of considerable height, probably nearly as lofty as the highest peak of β. It is shown by Schmidt (Sect. v.), but not individualized sufficiently, being mixed up with a number of low ridges of minor importance which are, as usual, coarsely reproduced in his map. West of α runs a tapering light streak, extending to a point north-east of β, where it dies out. Between this and the terminator is shown a formation resembling a coarse row of irregular chasms. I cannot trace this on the maps, but it is very obvious.

South of Euler lies the shallow ring-plain C, which is only noteworthy by reason of its surroundings. These mainly consist of a number of isolated little ridges and mounds which in their arrangement exhibit a very remarkable example of parallelism,—all of them extending towards the southern side of Euler.

The large crater B appears from its shadow to be a lofty object. It is associated on the north with a smaller crater, connected with B by a ridge. Schröter's representation of this region is one of his best efforts. With one or two exceptions he shows all the features just referred to, and notably the winding ridge which cuts through the wall of Brayley.

The halo and faint light streaks surrounding Euler well deserve careful study and delineation, but they must be observed at a more advanced stage of illumination.

Beaumont House, Shakespeare Road,
Bedford, 1896, November 19.

T. GWYN ELGER.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

The Manora Observatory.

GENTLEMEN,—

Miss Catherine W. Bruce (New York), the well-known Maecenas of astronomical observatories, has given a new proof of her disinterested generosity and ardent love to science, by sending us a sum of about £330 (4000 florins), in order to secure the useful existence of our observatory for some time, and to enable us to buy some indispensable instruments, viz.: a filar position micrometer (system Repsold-Clark-Heyde) with seven eyepieces (powers 146–735) and seven movable threads; a clock of precision by Riefler, to which the Gold Medal was awarded at the Nürnberg Exhibition, where, during six months, its rate was *less* than $0^s{\cdot}01$; and a big chronodeik by Ressel (optical parts by Reinfelder and Hertel, levels by Ertel and Son), with a power of 36 and 13 threads, and an object-glass of 2 inches. With these three instruments the precision of my future observations will considerably be increased. It is difficult to say how much I feel indebted to that noble American lady, but I beg you to publish these lines as a token of my gratitude.

My observations have suffered from the extraordinary bad weather during the last 15 weeks. Nevertheless I succeeded in discovering 20 new canals on Mars, besides seeing 70 Schiaparellian and 12 Lowellian canals. My fifty drawings contain also other interesting proofs of variations. Several of the Lowellian "oases" or lakes were seen by me, and a new one discovered. For the most part the canals are very broad, consequently probably double, although I cannot perceive the duplicity.

Manora-Sternwarte, Yours faithfully,
Lussinpiccolo (Istrien), 1896, Nov. 19. LEO BRENNER.

Proposed Students' Observatory in London.

GENTLEMEN,—

As a movement is now in progress for the introduction into the University of London of the means of giving instruction in those higher branches of science and literature which may tend to the encouragement of original study and research, and therefore fitly pertain to University, as distinct from College, teaching, I took it upon me, at the last meeting of Convocation, held on the 27th ult., to bring forward the claims of Astronomy in this respect by moving, "That the Senate be requested to take steps for establishing a students' observatory in the neighbourhood of London, for the instruction, primarily, of members of the University of London in practical astronomy, with the ultimate view of taking part in the progress of astronomical investigation." This motion was unanimously passed, and Mr. Coode Adams, who is a Member of Council of the Botanical Society, stated that a site was available for the purpose, which he felt sure would be granted, in the grounds of that Society (in Regent's Park), where a small meteorological observatory already exists. A member of Convocation asked me whether it would not be possible to have a department of the kind in the Royal Observatory, Greenwich; but it was obvious to point out that the whole of that institution is fully occupied in actual observing work of a character which will not admit of interruption. Moreover, the proposed students' observatory should be nearer London ; and perhaps no more convenient site could be suggested than that proposed by Mr. Adams, very near the late Mr. Bishop's Observatory, where Dawes and Hind made so many important observations and discoveries. Most of the great universities of the world have observatories in connexion with them, as, indeed, it is only fit and right that they should; and it seems to me that we only need some one capable of supplying the requisite endowment to enable the University of London to possess a similar institution, together with the means of training its students to make proper and efficient use of this. I hope for your powerful advocacy in this matter.

Yours faithfully,

Blackheath, 1896, Nov. 3. W. T. LYNN.

P.S.—May I take the opportunity of pointing out an erratum in my letter of Sept. 23, printed in your number for this month ? Page 401, line 6, dele the words "well acquainted with."—W. T. L.

NOTES.

COMET NOTES.—In addition to M. Perrotin's elements of Giacobini's Comet given last month, two other elliptical orbits have been published (Ast. Journ. 386, 387). The first is by Rev. G. M. Searle, and makes the perihelion passage 1896 Nov. 2^{d}·5, and the period 4^{y}·39. The second, by Messrs. Hussey and Perrine, makes the perihelion passage 1896 Oct. 25^{d}·5, and the period 9^{y}·32. An observation by Cerulli on Oct. 30, which is given in Ast. Nach. 3385, shows that the R.A.'s deduced from these three sets of elements had the following errors :—Hussey's R.A. 12 sec. too small, Perrotin's 7 sec. too great, Searle's 27 sec. too great. The following approximate set of elements has been deduced by a combination of the three, taking the above errors into account :—

Perihelion passage..	Oct. 27^{d}·1.
ω	140° 0′
☊	192 43
i	11 26
ϕ	38 16
$\log a$	0·5834
Period	7^{y}·5.
Perihelion Distance	1·459
Aphelion Distance	6·205

Acording to these elements, the comet was in Jupiter's neighbourhood for a long period in the year 1885.

The following ephemeris, deduced from Perrotin's elements, is given in Ast. Nach. 3386. It is for Berlin midnight. The R.A. of the ephemeris is probably too great by 30 sec. or thereabouts:—

	R.A.			S. Dec.			R.A.			S. Dec.	
	h	m	s	°	′		h	m	s	°	′
Dec. 4....	21	36	18	11	34	Dec. 24....	22	39	53	8	17
8....	21	49	21	11	0	28....	22	52	2	7	31
12....	22	2	15	10	23	Jan. 1....	23	3	58	6	43
16....	22	14	59	9	43	5....	23	15	43	5	54
20....	22	27	32	9	1						

Brightness on Dec. 4, Jan. 5, 0·65 and 0·39 of that at discovery.

A new comet (*f* 1896) was discovered by Mr. Perrine at the Lick Observatory on Nov. 2.

The following elements are by Prof. Kreutz from observations on Nov. 2, 4, 6 (Ast. Nach. 3386):—

$$T = 1897 \text{ Feb. } 6^{d}{\cdot}82 \text{ Berlin M.T.}$$

$$\left.\begin{array}{ll} \omega \ldots\ldots\ldots & 164^\circ\ 59' \\ \Omega \ldots\ldots\ldots & 85\ \ 10 \\ i \ldots\ldots\ldots & 146\ \ \ 5 \end{array}\right\} 1896{\cdot}0.$$

$$\log q \ldots\ldots \ 0{\cdot}0672$$

Ephemeris for Berlin midnight.

	R.A.			N. Dec.			R.A.			S. Dec	
	h	m	s	°	′		h	m	s	°	′
Dec. 3....	19	52	49	5	11	Dec. 19....	19	49	55	1	33
7....	19	51	40	3	23	23....	19	49	40	2	59
11....	19	50	48	1	36	27....	19	49	33	4	23
15....	19	50	17	0	0	31....	19	49	35	5	44

The brightness throughout this period is nearly the same as at discovery, since the comet is receding from the Earth, but approaching the Sun. In January and February it will be lost in the sunshine, but in March and April it will be a conspicuous object for southern observers, attaining in April a brightness some four times that at discovery.

Elements similar to the above have been computed by Dr. Halm and Prof. Knopf (Ast. Nach. 3386). Another set, not agreeing very well with the above, has been deduced by Messrs. Hussey and Perrine from observations at Mount Hamilton on Nov. 2, 3, 4.

The following is a continuation of the ephemeris of Brooks Periodic Comet (1889 V.):—

	R.A.			S. Dec.			R.A.			S. Dec.	
	h	m	s	°	′		h	m	s	°	′
Dec. 2....	23	2	36	6	40	Dec. 14....	23	21	39	3	59
6....	23	8	46	5	47	18....	23	28	20	3	4
10....	23	15	8	4	53	22....	23	35	8	2	8

A. C. D. C.

Minor Planet Notes.—'Bulletin Astronomique' for October contains a table of the results of M. Charlois' planetary photography during the past year: 39 plates were taken, on 11 of which no planet appeared; the remainder contained in the aggregate 52 planets, of which 46 were old and 6 new. He has now discovered 88 new planets.

Planet 345 has been named Tercidina. A. C. D. C.

A Hydrodynamical Investigation of the Solar Rotation.—In the part of Prof. Frost's address on the level of Sun-spots, reprinted in our last number, reference is made in a footnote to a paper by Dr. Wilczynski in support of the conclusion that Sun-spots are at a higher level than the photosphere. After examining Dr. Wilczynski's paper ('Astrophysical Journal,' August) we are compelled to say that it seems to us that no reliance should be placed on the hydrodynamical investigation given there. After remarking that the mathematical treatment of this subject by some astronomers lacks vigour, Dr. Wilczynski starts by quoting Lagrange's Hydrodynamical Equations, but only succeeds in deducing the equation $-\frac{1}{\rho}\frac{dp}{dr} + \frac{dV}{dr} + \omega^2 r = 0$, which could have been obtained in much less space by more elementary methods. In hydrodynamical investigations it is necessary to see that the equation of continuity and the boundary conditions are properly satisfied. Dr. Wilczynski considers neither of these points, and as the necessary conditions are not satisfied, the motion he assumes is not possible. We may further say that it looks somewhat incredible without any mathematical analysis. "If we therefore regard the axis of rotation to be surrounded by a system of cylinders, all the points situated upon the surface of one of these cylinders rotate with the same velocity. In other words, these cylindrical surfaces rotate as if they were solid. But from one cylinder to another ω (the angular velocity) changes according to a certain law, &c." *

This paper ought not to have been printed in the 'Astrophysical Journal.' Non-mathematical readers, seeing the great name of Lagrange in the midst of a formidable array of symbols, might easily believe that the later remarks of the paper rest on a dynamical basis. For instance, the article is gravely abstracted in the Journal of the British Astronomical Association by a writer who is probably more interested in the results as applied to the Sun than he is conversant with the hydrodynamical treatment of such questions. Unfortunately a good deal of bad mathematics finds its way into astronomical periodicals, and Dr. Wilczynski's paper is a glaring instance. F. W. D.

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* One mistake in the paper Dr. Wilczynski corrects in the 'Astrophysical Journal,' November. He had found that $\int \frac{dp}{\rho} = cT(1+\log\rho)$, where $p = c\rho T$, and T is variable, but no assumption whatever is made as to how it varies!

The Leonids.—Observations of these meteors on November 13, 14, and 15 were not numerous, although sufficient were seen to show that the Leonid stream is nearing the Earth's orbit. At Greenwich a few Leonids were seen in the early morning of the 13th, but the sky was overcast on the nights of the 13th and 14th. The following observations are collected from contemporary publications.

On the morning of the 13th (civil day) at Bridgwater, Mr. Corder saw 20 meteors, at the rate of eight per hour, but only five were Leonids.

On the morning of the 14th, at Bridgwater, 33 meteors were seen, the hourly number being 8 to 13, but the sky was often foggy. Leonids still in a minority, but a well-defined radiant was apparent at 146° +25°. At Belfast on this morning the sky was overcast. At Dewsbury, Yorkshire, 12 Leonids were seen, one of which, at $13^{d}\ 15^{h}\ 45^{m}$ (astronomical), is said by the observer (Mr. Blakesley) to have been as bright as Venus; another, at $14^{h}\ 40^{m}$, was brighter than Jupiter, and left a splendid broad streak, which lasted about one minute. At Belfast the sky was overcast.

On the morning of the 15th, at Bridgwater, 66 meteors were seen in about four hours, of which 43 were Leonids, the radiant being well defined at 150° +23°. At Belfast 9 Leonids were seen up till 2 A.M. by Mr. W. H. Milligan, who remarks that the radiant was "as usual." A correspondent of the 'Dumfries and Galloway Courier and Herald' says that on this morning, "Till well after 4 o'clock, there were not many visible; one about every 2 or 3 minutes. By 5 o'clock they markedly increased, and from $5^{h}\ 15^{m}$ to $5^{h}\ 45^{m}$ there was quite a shower, and between these times we counted about 60. At 6 o'clock the shower had ceased."

Obituary.—Following closely on the death of M. Tisserand comes the sad news of the death of Prof. Johann August Hugo Gylden, the eminent astronomer whose work lay in similar lines to that of the French *savant.* Prof. Gylden was born at Helsingfors in Finland, and after being educated at the University of that town became a pupil of Struve at the Poulkova Observatory. In 1871 he was appointed Director of the Stockholm Observatory, and in 1884 took charge of the Göttingen Observatory. His astronomical writings, which are encyclopædic, are chiefly of an advanced mathematical character. His latest work, 'Traité Analytique des Orbites Absolues des Huits Planètes Principales,' was referred to at some length by Dr. G. W. Hill in the address lately reprinted in these pages. He was a member of the Stockholm Academy of Science, an Officer of the Legion of Honour, and he had been President of the Astronomische Gesellschaft. Prof. Gylden died on the evening of November 9, aged 55.

The death is announced also of Dr. Julius T. Wolff, Director of a private observatory at Bonn, where he made photometric investigations. Dr. Wolff, who died at the age of 76, is said to have been the last of Argelander's pupils.

A SHORT paragraph in the 'Daily Telegraph' of Nov. 28 runs:—"Mr. Benjamin Apthorp Gould died at New York yesterday, from injuries sustained through falling downstairs." Assuming this to be the learned Editor of the 'Astronomical Journal,' as seems to be likely from the exact coincidence of name, we feel much pain in having to record another such great loss to the science, and one which comes so unexpectedly after reading Prof. Turner's paragraph on p. 455 of this number.

THE COMPANION TO PROCYON.—A telegram from Lick announcing the re-discovery of the close companion of Procyon runs as follows:—"Companion Procyon, magnitude thirteen, found Schaeberle, position 318°, distance 4″·6."

LEWIS SWIFT, whom adverse fate cannot entirely vanquish, contributes a list of 50 new nebulæ to the 'Astronomical Journal,' No. 388, which he has discovered with a 4½-inch telescope at the Lowe Observatory, California. These are, in general, very faint; but, as he says, the "low latitude +34° 20′ enables me to work in fields beyond the reach of Sir William Herschel, or of his son Sir John, except while sojourning at the Cape of Good Hope."

ON account of pressure on our space this month we are compelled to defer to future numbers notices of several interesting books lately received. Among these are the publications from the Cape Observatory mentioned by Dr. Gill at the R. A. S. Meeting, a volume of the German Transit of Venus Observations, the Autobiography of Sir G. B. Airy, the Memoirs of the late Prof. Pritchard, Vol. II. of M. Baillaud's 'Traité d'Astronomie,' and a volume from the Karlsruhe Observatory.

M. PERROTIN has resigned his post at M. Bischoffsheim's private observatory at Nice, in order to become an observer at the Meudon Astrophysical Observatory.

DR. MELDRUM has resigned the Directorship of the Mauritius Observatory. He is succeeded by his First Assistant, Mr. T. F. Claxton.

FROM AN OXFORD NOTE-BOOK.

THIS is, I suppose, the concluding chapter in the account of the Note-book's journeyings. It has been rather difficult to get it fairly started, not from lack of material, but from some obscure reason which may be classed under the heading Inertia. I have only a limited knowledge of others' experience, but personally I find it very hard to settle down to anything when on a journey, and especially in the train. There is an appearance of ample leisure, but it is difficult to concentrate the attention so as to make use of it; only the very lightest occupations, such as reading novels, or perhaps writing a letter or two, seem possible, and attempts to undertake anything so serious as these Notes only resulted in failure. At sea the conditions are just a little more hopeful, and now that we are two days out from New York on the good steamer 'St. Louis,' it seems advisable to make another effort to satisfy the cravings of our hungry editor before we reach England and unknown arrears of work.

By way of giving local colour, I may remark that the day is as fine as we could wish; one of the passengers has, indeed, just commended it as an "elegant day." The boat, too, is very comfortable and has a fair turn of speed. It is true that Col. Rivers called her yesterday a "wretched old hulk," because the run was only 435 miles instead of about 465; but we are beginning to suspect a vein of grim humour in the Colonel, and it seems possible that he does not always mean everything he says to be taken quite literally. For instance, he has been grumbling at the calmness of the sea, which is not usually considered a just cause of complaint. "Just my luck!" he said, surveying the gentle Atlantic swell with a look of disgust; "here was I expecting it to be quite rough, and I should have been sick, and corrected these days of over-eating and inactivity in the train; now I shall simply have to go on starvation diet." We do our best to console him by pointing out that we may yet have some rough weather, but he is afraid it will come too late to produce any effect. But this, I fear, is rather a digression. What I propose to write about is the Harvard University Observatory, if I only know where to begin. The fact is, we saw so much at Harvard, and it was so new, and what we actually saw suggested so many other things to us, that this last chapter is by no means an easy one to write; and that is an additional reason for its hanging fire.

On mature reflection, I think the most noteworthy point about Harvard Observatory is that it deals with the whole sky, and not a hemisphere only. It is true that the photographs of the southern hemisphere are taken at the branch establishment at Arequipa; but they are examined and discussed at Harvard, and there is thus no portion of the heavens with which Professor Pickering is not actively concerned. Moreover, he is not content with a single set of photographs of even the whole sky, but has already photographed the heavens several times over in different ways, and proposes to continue doing so at more frequent intervals in the future. The frequency with which the sphere can be covered with photographs depends, of course, on the field covered by each, and the exposure given. After trying various schemes, from one which would cover the whole sky in a single fine night, to one which occupied a year and gave correspondingly more detail, Professor Pickering has recently decided to take the month as his unit interval; and an apparatus is now being arranged for taking plates ten degrees square (about 450 of which will cover the celestial sphere), with which it is hoped to obtain a complete picture of the northern hemisphere once a month. The apparatus is automatic, and will only require attention once every three hours.

Eight plates are put into a drum; and when one has had an exposure of 20 minutes, which ought to give stars to about the 14th magnitude, the instrument automatically changes to a new field of stars and to the next plate. Thus after 2 hours and 40 minutes all the eight plates will be exposed, and it merely remains for the assistant to take them out for development, put in a new set, and start the instrument for the next 3 hours. These monthly maps of the sky will not necessarily be all retained at the Observatory; we gathered that if other observatories should wish for them, it may be possible to supply them at the cost of $100 per sky; and the opportunity seemed to me such an excellent one that I begged permission to register an order at once.

THE possession of a huge collection of photographs such as has been gradually accumulated at Harvard renders possible methods of procedure which are quite new in astronomy. Hitherto, and in other observatories, when a peculiar object (a star with a large proper motion, or a variable, or with a peculiar spectrum) has been discovered, it has been put on the working list for observation, and its future history carefully followed; but little or nothing could be found out about its past. At Harvard it is possible to follow this history back for months or years by means of the photographs. In whatever part of the sky the object may be, there are probably 20 or 30 photographs of the region containing it in the Harvard collection—some of them simple stellar maps, others maps of spectra—and these are immediately looked up. New objects have been so frequent of late that it is not always possible to go through the plates at once; but they are taken out of the shelves and collected together for examination; and in the observatory one sees several of these piles of plates, each labelled with the name of the new variable or other object which they contain, and awaiting the time when Mrs. Fleming or one of her assistants can examine them.

THE spectacle of a large collection of astronomical photographs being used so regularly and to such good purpose is most reassuring. I confess that at times I have doubted the advantages of taking photographs faster than they could be properly measured or otherwise adequately examined; it seemed so much like the old astronomical blunder of piling up observations without reducing them. But here is a working collection of plates, many of which indeed, are thoroughly examined as they are taken, but many, on the other hand, are put aside after the briefest inspection, on the chance, so to speak, of their being useful in the future; and the result is excellent. The collection is serving a straightforward practical purpose of the greatest importance, and is clearly not in the least wasteful; indeed, any false economy which attempted to restrict it to particular regions or particular times would almost inevitably result in the disaster of omitting just what happened to be wanted.

The collection has not as yet been used for any extensive determination of positions of the stars; perhaps it is not very well adapted to such work, for most of the photographs are taken with doublets, and the distortion over the comparatively large fields would have to be carefully studied. At the same time any special case of proper motion or parallax could no doubt be treated differentially. Systematic examinations of the plates have hitherto been either for estimations of brightness or for classification of spectra. The amount of photometric work done at Harvard is simply enormous, and we may, perhaps, regard the observatory as one great Photometric Observatory. The classification of spectra may very well be considered as part of the legitimate work of such an observatory, for it supplements the determination of quantity of light by assigning the quality in addition; and thus the different methods for photographic photometry, the meridian (visual) photometry at which the Director works for four hours every fine night, the observations of variable stars, the photometric observations of the eclipses of Jupiter's satellites, and the classification of spectra may all be regarded as contributing towards a single definite aim, the photometric exploration of the sky.

This ship vibrates after the manner of a beam under no constraints, with nodes about a third of the length from each end. Walking along the deck one finds a considerable vertical oscillation amidships, which becomes insensible at points about opposite the library door and in front of the smoking-room respectively. I have just taken a turn along the deck to verify the positions of these nodes, and find they are in the same place as yesterday. Simple amusements such as these are not to be despised on a sea voyage. Returning to these notes, and particularly to the last paragraph, which enumerates some of the main activities of the Harvard Observatory, it seems to me I ought to devote at least a note to each of them, though a volume would be more appropriate.

As regards, then, the different photographic methods for estimating the brightness of the stars, there is one deserving of special mention as being quite novel, and, so far as I know, peculiar to Harvard. It consists in taking a photograph sensibly out of focus, so that each star forms a splotch on the plate instead of a small image: the deposit of silver is spread over an area, and is nearly uniform in density over that area; though the density, of course, varies with the brightness of the star. (The appearance of plates taken in this way is almost more curious, at first sight, than that of plates of spectra.) The brightness of the star is then determined from the particular shade of grey which this area presents, the estimation being made by comparison with a standard set of such discs, of different shades. The density might, of course, be actually measured in the manner adopted by Capt. Abney; but Prof. Pickering prefers the comparison with a scale, as more rapid and at the same time sufficiently accurate. One vital point must be mentioned: it has been established by experiment that the density of deposit is sensibly the same in whatever part of the plate the same star is photographed. As the plates cover a considerable field, this is not only convenient but a little surprising. Prof. Pickering takes the explanation to lie in the compensation of the curvature of the field by the use of a doublet lens. The plate is well within the focus for the centre of the field, but is approaching focus for the edges; thus, other things being equal, the light of a star at the centre would be thinly scattered over a large area, that of a star at the edge of the field concentrated within a small area. But for the latter the available aperture of the doublet is automatically cut down, and thus the concentration is corrected. This interesting explanation is well worthy of detailed investigation; but having established the main fact with sufficient accuracy for his purpose, the Director has commenced regular work on the stars, and the comparison of results obtained by this ingenious method with others will be of great interest.

THE meridian photometer has been described in detail more than once, and it seems needless to repeat any description here. It belongs to that class of instruments, of which the equatorial coudé is a conspicuous instance, where the observer retains one comfortable position throughout the evening, and need not suffer from cold, the stars being reflected by mirrors into a fixed telescope. There are some kinds of work for which this arrangement is not suitable; but it seems probable that there are many others where it would be of the greatest advantage, not only for rapidity and comfort, but for accuracy. The meridian photometer is quite a beautiful instrument to see at work, and it is scarcely profitable to add to this statement; for in such a practical question as the working of an instrument, a few minutes' inspection is better than whole volumes of description. I give, therefore, this statement, as the testimony of three witnesses, for what it is worth. The competence of the witnesses may, of course, be questioned, though I hope no one will be unkind enough to call us "experts." There is, however, one other remark to be made, which says something for the meridian photometer, viz., that the Director of such an observatory as Harvard, with so many other pieces of work on his hands, finds the instrument so fascinating that he has for years worked with it every fine night for four hours at a stretch. This is food for reflection for those who have spent whole minutes making up their minds whether it is not too cold for work, or too much trouble to open the dome.

CONCERNING variable stars, I must say at once that the subject cannot be exhausted in a single paragraph. There is a large notice-board in the Observatory covered with diagrams of the light-curves (visual and photographic) of different variables, which we studied with much edification for a considerable time; and one may see in odd corners rows of photographs illustrating the variations of a single star. But passing over these with this brief mention, I should like to describe, for the benefit of those who have not seen the description elsewhere, just how the last Algol variable was discovered by Miss Wells. It was the product of a definite search for peculiar objects, and especially for stars with large proper motion or parallax or variable in brightness, which has recently been started at the Observatory. If a plate be exposed twice on the same region at an interval of six months, giving, of course, a slight displacement so that each star appears double, then variations of brightness would be apparent in a manner which needs no further explanation. Large proper motion or parallax would be apparent on measuring the distances and position-angle of the fictitious doubles and noting exceptional cases; and proper motion could be distinguished from parallax by taking a third exposure of the region six months later. But as it stands this is scarcely a practicable scheme; it has been rendered practical by two ingenious devices. The first gets over the difficulty of keeping a plate undeveloped for six months. Two plates are actually exposed, but one of them *through the glass plate*, so that the images are really on the back of the film. The two films are then placed in contact, and there is virtually obtained a plate with two sets of images, as above. The second device is labour-saving simply. To measure the distances and position-angles of all the artificial doubles would be a tedious business, and yet rather careful measurements are needed to detect a displacement of say 0″·5. But if such a displacement occurs in position-angle, the eye can detect it with some facility, especially when aided by a microscope with a single wire placed parallel to the average displacement of the images. The artificial doubles should thus be arranged so that any parallactic displacement comes wholly into position-angle, and then the detection of stars with large parallax is comparatively easy. Parallax- and variable-hunting on this plan has been in the able hands of Miss Wells for some time, and one result has been the discovery of W Delphini. An interesting general result, though a negative one, of the investigation up to the present is that such objects are rarer than might be supposed. It is, of course, possible that some escape even this exhaustive scrutiny; but on this head it is reassuring to learn that such objects as Groombridge 1830 or 61 Cygni, which were on the plates *unknown to the scrutineer*, were nevertheless detected in the ordinary course. On the other hand we learnt that, in the course of the general inspection of the spectroscopic plates of the southern sky, 8000 objects have been noted as possibly peculiar. It will take some time to go through the sky, and one may confidently expect a goodly crop of results from this search.

ECLIPSES of Jupiter's satellites have now been observed photometrically at Harvard for more than a complete revolution of Jupiter, and the results are nearly ready for press. By means of a photometer, similar in principle to the meridian photometer, the light of the satellite undergoing eclipse is compared with that of one of the other satellites, just as two stars would be compared; [illegible] the comparisons are made as rapidly as possible, two or three observers helping at the same telescope. The gain in accuracy by this method is very large, as will be clear from the consideration that 20 or 30 observations are substituted for the single one of disappearance by the ordinary method; and from these a curve of the diminution in brightness can be plotted, and used to determine the time of half-brightness or of disappearance as desired. The latter would correspond to the determination of the asymptote of the curve. Moreover, the method has a conspicuous advantage in the case of reappearances for which the time observed by the ordinary method is probably late systematically. It is, perhaps, well enough known that this work has been proceeding at Harvard, but it is strange that with such obvious advantages it has not found a place in the programme elsewhere. Perhaps the publication of the Harvard results may draw to it the attention necessary for due recognition; but it is curious to note how slow even the scientific world is to take advantage of a promising opening. When a new idea of any merit occurs to us we are often foolish enough to be afraid lest some one else should appropriate it before we have had a fair chance to develop it; whereas the anxiety should rather be whether, after it is completely developed and put into a practical shape, we should ever be able to persuade anyone else to take it up. Why is it, for instance, that no one else has yet taken up Mr. Chandler's Almucantar, or that Mr. Hale's spectroheliograph work has had so few followers?

THE spectroscope is an instrument with which I have not had much to do, and I would sooner not risk getting into trouble by saying anything of the general spectroscopic work at Harvard. But there is one outcome of it which seems to me of such wonderful significance that it can scarcely be mentioned too often, viz.: the extraordinary distribution of the fifth type. stars. There are now, I think, about 70 of these stars known, of which the great majority have been discovered by Mrs. Fleming in the regular examination of photographs; and all these, without a single exception, lie in the Milky Way. There is to be seen in the Observatory a chart of the celestial sphere, on which is drawn a great circle representing the central plane of the Galaxy, and on which also the positions of all these 70 stars are indicated; and it is seen at a glance that not one of them is more than two degrees from this great-circle. Is there any other known fact so significant as this in regard to the structure of our universe? As it stands, its full significance is not determined. It would seem as though the sidereal universe must be flat in shape and these stars very distant; but their parallaxes must be examined before we can declare this definitely. These stars will no doubt well repay any trouble spent on them.

SOME of us are not satisfied with the pace of this ship. When we get our faces turned homewards, we are mostly like Mr. Gilead P. Beck when running away from the bear—our "primary object is speed": and here we are in a ship which ought to be doing

20 knots, and the run every morning shows only 19! It is clearly difficult to be content under such circumstances, though we try to find compensations: for instance, if our worst prognostications are realized, and we begin to go backwards towards New York, I can get enough notes written to last for months to come. If the astronomical material gives out, there are several good stories that might be made use of, especially Col. Rivers's story about the army-clothing storekeeper and the rat-traps; also the Junior Member of the Expedition has reminded me of several incidents of travel which were not mentioned in their proper place. Indeed, I fear I have altogether failed to record the most interesting events of the last few months; for on consulting the Junior Member I found that the half-dozen conspicuous things which were on the tip of his tongue had quite escaped my vigilance. The omission shall presently be rectified, but it seems better to express regret at once, especially as a slight occasional digression of this kind seems to be good for the flow of the pencil.

BUT I begin to despair of telling all we saw and heard at Harvard. It is a veritable treasure-house of astronomical ideas, of all sizes; and I can only make brief reference to a few of them here. There is a pretty device for giving an accurate exposure of one second, in photographing "standard squares" on a plate. The exposing-shutter is a seconds' pendulum held aside by a trigger. When the trigger is pulled, the pendulum swings, makes the exposure, and catches on the trigger again. Then there is a neat way of giving all the bright stars on a photograph a supplementary short exposure or the equivalent: a tiny prism of very small angle is cemented to the object-glass, and slightly diverts a portion of the light of a star so as to give a second image, which, however, only shows on the plate for bright stars. This device has a considerable photometric importance, for the "prismatic companion," as the small image has been called, is a definite number of magnitudes fainter than its primary; and if we find by experiment, for instance, that when the primary is of the fifth magnitude, the prismatic companion is of the ninth, then we have the means of determining a thirteenth magnitude star from a ninth, and a seventeenth from a thirteenth. There is a special instrument devoted to the North Pole—a fixed telescope for photographing the region of the pole every night, opened and shut by two ordinary alarum clocks, which are set to the appropriate times. Incidentally, this instrument gives of course a record of weather, for when clouds cover the pole the star trails are interrupted; and information of the same kind is afforded by the little "patrol," which kicks its way all over the sky every night and photographs all the stars down to the sixth magnitude. Small wonder that with such a variety of instruments and apparatus the output of results at Harvard should be so large. There is a shelf in Prof. Pickering's study nearly full of 'Harvard Annals,' and he hopes to have it quite full shortly, though there were only some half-dozen volumes when he came to the Observatory nineteen years ago. The shelf seemed to me to be about ten yards long, but I had no opportunity of actually measuring it, and this estimate is perhaps a little large. Anyhow, I heard mention of volume 54 as either complete or nearly so.

SEPTEMBER is a satisfactory month in which to go and see other observatories, in that there is little to keep one at home; but it is unsatisfactory in that other people are away on holidays also. We must consider ourselves very fortunate to have seen so many astronomers during our visit to the States. To Mr. Chandler we owe a particular debt, for he came to Boston from his summer residence specially on our account, and spent the evening of his 50th birthday with us in Dr. Gould's hospitable house. We found Dr. Gould still reminiscent of his nasty accident from a runaway horse, but full of energy and kindly humour as ever. I wish he would write down some of the many astronomical stories he has to tell! But such pious wishes are seldom realized.

FROM Boston we went to Washington. The U.S. Naval Observatory has been recently removed to a site a few miles from the city. Some fine buildings have been erected and whitewashed where necessary; and many excellent instruments are all ready for use.

The system of appointing as Director a naval officer whose knowledge of astronomy is limited by nautical requirements, and changing him every few years, is still in force. It will perhaps be kinder not to say more of this national observatory until this system is altered.

WE made a pilgrimage to Baltimore, the Home of the Grating. Prof. Rowland was not at home, but his assistant, Mr. Ames, did his very best for us; and especially he showed us the ruling-machines, both at rest and at work, and made Mr. Schneider tell us all the secrets of grating-ruling, which, of course, wild horses would not tear from our bosoms. But I think we may relate a little incident which had occurred: it may serve to illustrate the joys of this occupation. When a grating is to be ruled, the first requisite is a fine point on the diamond. Mr. Schneider finds this by trial, turning the diamond this way and that, and ruling some lines in each position until he gets a satisfactory one. For ruling a special grating required just now by Mr. Ames, he had been a little matter of eighteen months searching for a nice point, and had at last found one and set it to work. The grating was just about half-ruled when some visitors were admitted for a few moments to see the machine at work—not, of course, mere casual strangers, but visitors who knew something of such matters. One of them was so well-informed that he knew exactly where the diamond was working, and indicated it to the others by putting his finger on the holder; and so Mr. Schneider lost his eighteen months' labour and has begun looking for a new point.

In spite of such mishaps, gratings are plentiful at Baltimore. There are three machines, two of them in working order, and they are worked pretty constantly. The world's supply is thus quite copious at the fountain head, however thin it may appear at a distance; indeed at Baltimore one's opportunities of being familiar with gratings are so numerous that, although contempt is naturally out of the question, still it actually does not fill everybody in the place with consternation if an accident happens to a grating. People even speak of such accidents in an ordinary tone, without bating their breath appreciably. We felt that we had lost a pious illusion by our brief visit to Baltimore.

The most beautiful thing in the ruling-machine (excepting of course the screw, which one knows, but cannot see, to be nearly perfection) is the device for correcting the small residual errors of the screw itself. It would take diagrams to explain it in detail; and a full description has probably been published in some place accessible to the curious. But the general principle is readily intelligible. The periodic errors of the screw are determined experimentally, and show that in some parts of the revolution it is too far forward, at others too far behind, and would produce corresponding errors in the ruling of the grating, which is carried forward on a nut on the screw. To compensate them, a long arm is attached to the nut, and the end of the arm is worked backwards or forwards so as to give a very slight rotation of the nut on the screw, sufficient to correct the errors, yet not enough to sensibly disturb the plane of the grating surface.

We heard with surprise and admiration that the fame of Baltimore and Prof. Rowland bring to the University annually some 20 or 30 students in *advanced* physics. Considering the number of other universities and institutions in the Eastern States, this is a very large number. No doubt they will still come from afar to hear the *ipsissima verba* of famous men, whatever advances may be made in our methods of communication at a distance—a reflection suggested by the recollection of an apparatus, which Prof. Rowland himself has just completed, for type-writing at a distance of a few hundreds or even thousands of miles. By this apparatus the following small scheme is rendered practicable: eight persons can sit down in Baltimore to eight separate sets of keys and type eight independent letters or poems; and over one and the same wire the results will be flashed to New York, and there appear type-written on eight separate pieces of paper. The simultaneous transmission of eight messages over the same wire is arranged by using different and incommensurable periods between the signals.

One of our greatest regrets was that we had not time to see Princeton and Prof. C. A. Young. Even four months comes to [illegible] end at last, and we had rather a hustle to catch this ship, [illegible] is only a day and a half from Southampton by this time, and is beginning to show how much coal has been taken out of her by rolling through about 35° one way and 25° the other. Even rubber shoes do not feel quite safe on the deck at times. However, she is behaving well in other ways, and we all felt quite grateful to her this morning for having registered a run of 469 yesterday. There is but one clear day more of idleness, and I think I had better at once go back to the incidents of which the Junior Member has reminded me, while yet there is opportunity to repair my careless omissions.

THE first place in his list was given to the story of "Colonel Rivers going backwards." This refers to an occasion when the Colonel had gone one day ahead of the rest of the party, and was travelling, in the end car of a heavily loaded train, up and down the slopes of the Rockies. In going up a fairly steep slope the train broke in two, and the rear half, containing the Colonel, did actually start backwards down the incline, though the powerful brake was sufficient to pull it up very quickly. Such incidents of travel are not uncommon on the line of the enterprising C. P. R., though serious accidents are rare, and loss of life almost unknown. Lower down in the list I see I am reminded of "the tea falling into the river," which represents a little contretemps with a freight train when passing over a bridge. The bridge had been too severely tried by the torrents and gave way under the train loaded with tea, which was thus deposited in the floods below; and the passengers by the next train (the Junior Member being one), who had to wait a day or two till the bridge was repaired, were much interested in this accidental tea-making on a large scale; where the tea pot was a river bed, the spoonfuls of tea were wagon loads, and the water was only boiling in the sense allowed to licensed poets when speaking of a torrent.

THE next omission concerns the Korean minister, who was indeed mentioned in these notes, but only as being a little anxious to avoid assassination. His really remarkable trait, overlooked by sheer carelessness on my part, was his despair when he found that he could not take with him in the "parlour-car" half-a-dozen large trunks, containing changes of costume for himself and family. He had no small luggage of any kind, and we can only speculate what his six days' journey from Vancouver to Washington can have been like after the ruthless conductor had banished all the trunks to the baggage-car.

I PASS lightly over the death of a large porcupine which was caught on the track by a passing train; and am next to record the fact that when we were on board H.M.S. 'Pique,' Lieut. Grant allowed us one morning to shoot with a Morris tube at a paper target, which we riddled with holes. I think that was a red-letter day for the Junior Member. By comparison with it, all the rest of the time in Japan pales into insignificance: his actual words, spoken next after recalling that glorious morning, and taken down by me at the time, were—"Let's see! we can't get anything else out of Japan. Can we?" And after much thought the only remaining noteworthy event seemed to him to be the interviewing at Chicago, which happened to be a thing of yesterday, and was therefore fresh in his memory. In obedience to his command, therefore, I reproduce here the first few sentences of one of the interviews, leaving it to the reader to guess at the amount of truth involved:—

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"Say, professor, how is the fifth satellite looking now? You know I haven't had a peep at her since I left Japan."

"Bless my heart. I haven't seen her either for three nights. Jupiter's getting pretty well down in the south, though."

Those were almost the first words that Prof. W. H. M. Christie, F.R.S., F.R.A.S., Royal Astronomer of Great Britain, and Prof. E. E. Barnard of the Chicago University addressed to each other yesterday when they sat down in the stern of George C. Walker's yacht to get acquainted.

The Royal Astronomer, wearing low shoes and a straw hat, walked round in the Wisconsin mud yesterday at Lake Geneva and inspected the new Yerkes astronomical observatory of Chicago University.

THIS will be perhaps enough to give a notion of the interview, which becomes rather more personal further down, though perhaps I might add a sentence attributed to Col. Rivers, which I take my solemn oath I never heard him say. But the interviewer reports him as follows:—"Of course you have got the largest telescope and the largest and handsomest observatory, but we have got the biggest reputation. You have a strong faculty and you will have to make the reputation." And I think now the Junior Member ought to be satisfied with the publicity into which he has dragged his fellow-travellers. I am also grateful to him for his suggestions and shall consult him earlier on the next occasion.

THAT next occasion, we are all resolved, shall be 1898 Jan. 21–22; and we shall thus hope to leave England early in the preceding month. Japan did not treat us well; perhaps it resents the intrusion of foreigners; but in India we shall be at home and may hope for better luck. And with the expression of this hope I must bring these disjointed notes of our wanderings to a conclusion. To be picturesque, I suppose we should at this point be just sighting Southampton, and the glad vision should wring a cheer from my patriotic pen (the derangement of epitaphs being symbolic of emotion). But strict truth compels the admission that we have been in England more than a week before the last few lines became written, and not only Japan and the Eclipse, but the States and the good ship 'St. Louis' are now pleasing memories.

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THE
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